



The Blast Furnace and Steel Plant

Published the first of each month by the National Iron and Steel Publishing Co.

Main Office — Thaw Building, 108 Smithfield Street, Pittsburgh.

DISTRICT OFFICES — NEW YORK AND CHICAGO.

President: H. A. Andresen. Vice President and Treasurer: F. C. Andresen. Secretary: M. M. Zeder.
Engineering Editor: ALFRED M. STAEBLE. Associate Editor: A. W. PETERSON.

EDITORIAL ADVISORY BOARD:

William A. Field W. Trinks Fred Crabtree Kenneth B. Lewis
Barton R. Shover Dr. George B. Waterhouse E. H. McClelland A. G. Smith

Subscription Price:—In the United States, \$1 per year; Canada, \$1.50; all other countries, \$2. Single Copy, 15 Cents.
Entered as second-class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.

Index to Contents

VOL. VII.		MARCH, 1919.		No. 3.	
	Page		Page		Page
CHINESE BLAST FURNACE IRON CON- VERSION	125	RELIABLE PERFORMANCE OF LARGE TURBINES	147		
BY C. T. HUANG.		INTERNATIONAL INFLUENCE ON STEEL INDUSTRY	149		
THE BLAST FURNACE AS A GAS PRODUCER	127	BY L. W. ALWYN SCHMIDT.			
NOVEL PLATE TURNOVER FOR TAN- DEM MILL	128	FURNACE COMPANY COMPLETES NEW PLANT	152		
METALLURGICAL WORK OF BUREAU OF STANDARDS	130	PRACTICAL POINTERS ON HEATING FURNACES	153		
BY G. K. BURGESS.		BY GEORGE J. HAGAN.			
IMPROVEMENT MADE IN GAS REVERS- ING VALVE	132	INVESTIGATION OF GASES OCCLUDED IN STEEL	156		
DOES FORGING INCREASE SPECIFIC DENSITY?	133	BY THOMAS BAKER.			
BY H. E. DOERR.		FOREIGN RELATIONS	158		
HEATING FURNACES AND ANNEALING FURNACES	134	PRODUCTION TOPICS	160		
BY W. TRINKS.		NEWS OF THE PLANTS	161		
GEARED VERSUS DIRECT COUPLED MOTORS	138	INDUSTRIAL RELATIONS	162		
BY R. W. DAVIS.		SOME POINTERS ON BY-PRODUCT COKE OVEN OPERATION	163		
PRESENT AMERICAN ACID BESSEMER PROCESS	140	OPEN HEARTH	164		
BY RICHARD S. M'CAFFREY.		WITH THE EQUIPMENT MANUFAC- TURERS	166		
MANGANESE ALLOYS IN OPEN HEARTH PRACTICE	142	TRADE NOTES, TRADE PUBLICATIONS, OBITUARY, SOCIETY MEETINGS	168		
BY SAMUEL L. HOYT.					

Chinese Blast Furnace Iron Conversion

Smelting of Native White Iron into Foundry Pig Iron Is Not Simply a Melting Process, but Involves Metallurgical Conversion. Part of Combined Carbon Changed into Graphitic Form.

By C. T. HUANG.

Blast Furnace Engineer, Hangyang, China.

Owing to the European war there is great shortage of pig iron in the Far East, due to the American embargo on pig iron exports. The supply of pig iron from China and Japan is not enough to meet the demand, so the price of iron has jumped up from 30 taels to 170 taels per ton. (According to the present rate of exchange 1 tael equals \$1.29 gold.) There are about 150 native iron blast furnaces in China capable of producing two to six tons of pig iron per furnace per day using cold blast, and it is certain that these furnaces cannot produce suitable iron for foundry use, as the sulphur content of the iron is sometimes as high as .125 per cent, and silicon as low as .30 per cent, but sometimes they can produce good basic iron, because most of them use charcoal as fuel. The only modern iron and steel works owned by Chinese in China is the Hanyang Iron and Steel Works, and of course there are still some others of the modern type in China and in Japan but, the total production of them is not enough for the demand of the Eastern market. Dr. Z. T. K. Woo, of Hanyang, suggested the remelting of all the iron plates used for pavement in the works, for the purpose of changing them into good form so that they can be sold at high price. We had successfully remelted 1,000 or 2,000 tons of plates in our blast furnaces at the beginning of the year, and procured a good profit through the increased production. As the demand of pig iron is so great and the price is so high (about 170 taels per ton at the time I am writing) our superintendent has proposed the purchase of all the native white iron at low price to be remelted, and converted into good grade iron in our furnaces, and asks the writer to make a trial of the native iron, i.e. to convert them into good iron in our blast furnaces. Our works comprise four blast furnaces, two small ones and two large ones, the smaller ones rated at 100 tons each per day, and the large ones at 250 tons each per day, but owing to shortage of transportation of coke on account of the war, one of the large furnaces is shut down and is being repaired.

The smelting of the native white iron into foundry pig, according to my idea, is not simply a melting process as is the case of remelting of our foundry scrap or iron plate of good quality, but involves a process of metallurgical conversion, changing part of the combined carbon into graphitic form, the removal of sulphur down to the permissible limit and the impregnation of silicon up to about 2 per cent. It requires heat to melt iron and much more heat to convert the white iron into foundry. The hearth heat in the blast furnace is only sufficient for its own work, therefore it is necessary either to lighten the burden or to increase the coke consumption for the smelting of the native white iron. The amount of heat is equivalent to one ton coke to four tons iron. After trying I found that our three furnaces which are now running, could take up only 40 tons of native iron equivalent to 10 per cent of the daily output, without interfering with the normal working of the furnaces. This is governed by the relation of iron to the slag volume. It is through the medium of slag that the sulphur is partly if not all, eliminated, silicon is impregnated and carbon is changed into the graphitic form. It may be possible for the furnace to smelt a higher tonnage than 10 per cent of its own capacity by adding slag and coke to the charge, but we must not forget the fact that the slag and coke occupy space, sacrificing the furnace capacity. There is another point which puts a limit upon the smelting of the native white iron more than 10 per cent of the furnace capacity. Uniformity in the distribution and descent of the stock is of prime importance in smooth working and good running of blast furnaces. We note that scrap iron charged together with ore, limestone and coke into the furnace descends much faster, causing chilled hearth and the production of off-grade iron. This is because of the higher specific gravity of iron compared with other constituents of the charge, and the action of differential sinking and separation resembles closely that of a pneumatic jig used in

ore dressing. This jiggling action was observed and proved to have taken place in the blowing out of one of our furnaces, as we had charged, on blowing the furnace out, 80 tons of limestone on the top of the charge, and on raking the material out, we found that the limestone came down to the hearth quicker, leaving a large blank of coke on the top showing very clearly a distinct and separate layer of coke and limestone. This goes to support my theory that we cannot charge too much white iron into the furnace at a time simply because of the difference in specific gravity, if so, there will always be a chilled hearth. Recently we experimented in adding more scrap pig than the amount permitted into one of our furnaces and at the same time lightening the burden, the result was always the chilling of the hearth and the production of bad iron, which requires remelting and conversion in the furnace again. To raise the hearth heat, the furnace with a light burden has to be run with a decreased supply of blast which imparts a higher heat to the slag, giving rise to hanging and other consequent irregularities. Therefore from the above consideration it is rather risky to smelt more than 10 per cent of the furnace capacity. The cost of smelting white iron into foundry is as follows:

Taels 3.211 coke (1 ton of coke to 4 tons of iron)
 Taels 0.055 coal
 Taels 0.728 labor
 Taels 0.603 materials
 Taels 2.164 general expenses
 Taels 1.000 duty

Taels 7.761 total cost per ton.

The above cost is only approximate, but we believe that the figure is fairly accurate for making estimates. It will be seen that the transportation and marketing charges are not included in the list of items here. There is another point which is very important, to which I wish to call attention, that is, the displacement of ore charge, by the native white iron, decreasing the furnace capacity for smelting our ore which percentage of Fe is about 60 per cent. For every 250 kg. of white iron entering into the furnace per charge, we have to lighten the ore burden by 100 kg (ore) equivalent to 60 kg Fe. The average number of charges in our three furnaces per day is 160 which means that the capacity of the furnaces for smelting ore is reduced by 9.6 metric tons of iron as against 40 metric tons of white iron smelted in place of the ore.

The relative profit and minimum selling price for smelting the white iron is of prime value from a commercial standpoint because the cost of producing one tone of iron from the ore is much lower than that from the native iron, and consequently the profit made from smelting the ore is proportionately greater. Whether it is judicious to purchase native white iron and then convert it into foundry pig in the blast furnaces, hinges upon the additional profit which could

be gained from this transaction without lowering the profit which could be gained from the smelting of the ore (on account of the displacement of the furnace capacity). The problem due to the difference of the first cost prices, is then resolved upon the condition that the profit made from smelting 40 tons native iron per day should be greater than that lost through displacement of furnace capacity of 9.6 tons of iron from ore smelting. To solve this problem it is necessary to determine the minimum selling price of the iron at which no profit can be made and this is really the keynote of the whole solution.

Let K = minimum selling price at which the profit made from smelting native iron is balanced by the loss of furnace capacity for ore smelting.

x = Cost price of native iron Ex-Hanyang furnace.

A = Smelting cost per ton of native iron at Hanyang furnace.

40 = tons of native iron that could be smelted per day.

9.6 tons of iron from ore is smelted but lost by displacement through the smelting of 40 tons of native iron.

$[K - (A + x)] 40 - 9.6 (K - 20) = 0$ (no profit) as long as the smelting price is above the value of K the deal in native iron will be profitable.

The price of native iron is variable from 50 taels to 95 taels per ton. Supposing we assume cost price of native iron per ton = 50 taels then

x = Taels 50 price per ton ex-Hanyang furnace

A = Taels 7.8 cost of smelting per ton of white iron

K = minimum selling price

$[K - (7.8 + 50)] 40 - 9.6 (K - 20) = 0$

$40K - 312 - 2000 - 9.6K + 192 = 0$

$30.4K = 2120$

2120

$K = \frac{2120}{30.4} = 69.77$ taels

The price of foundry iron is 170 taels per ton, therefore by smelting one ton native iron we can get a profit of 100.23 taels. There are about 500,000 tons of native iron in China, if we can convert them into good foundry pig, then we will make a profit of about 50,000,000 taels. The question now lies how many tons of white iron can we convert in a day into foundry pig so as to make the profit quickly. From the above, we note that one furnace can handle only 10 per cent of its own capacity which puts a limit upon the "quick profit." I have been thinking of smelting the white iron in a separate furnace mixing with proper proportion of slag and coke and a little manganese ore. The native pig has to be broken to proper size before being charged into the furnace. By doing so we can avoid the separation of native iron from other constituents due to jiggling action, to a certain extent. The original size of the native pig is in the form of a brick $10 \times 8 \times 1$ inch. By using this method I believe a 100-ton furnace can handle 300 to 400 tons of white iron a day easily using hot blast.

The Blast Furnace as a Gas Producer

German Blast Furnace Practice Which Aimed by Increasing Coke Consumption to Produce More Gas With Same Quality of Iron Shows Enhanced Calorific Value of Gas on Balance Sheet.

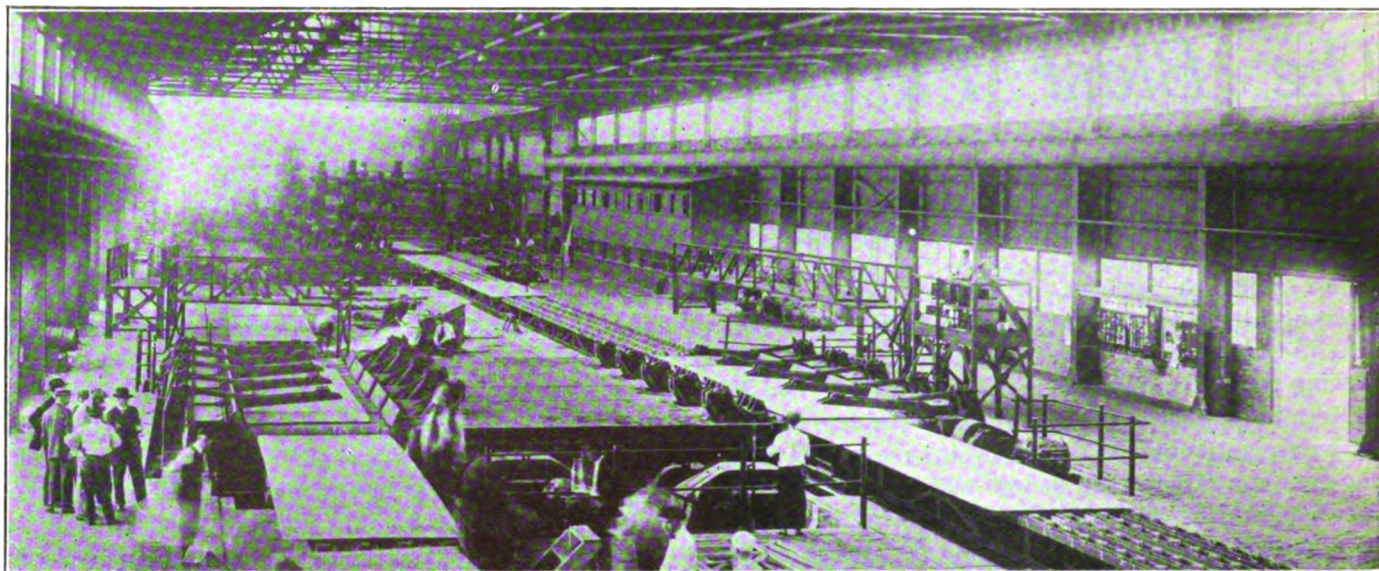
Herr Friedrich Siemens, of Berlin, contributes an interesting article to a recent issue of *Stahl und Eisen*, on the use of gas in and about iron and steel works, the following translation and abstract of which appeared in the December 6, issue of the *Iron and Coal Trades Review*. The writer introduces the subject by remarking that using gas on a larger scale in iron and steel works is a somewhat complex problem. Let us assume, he states, that a works requires something like 44,000,000 cubic feet of clean producer gas, of 1,200 calories, in 24 hours, and that the efficiency of the producer is 65 per cent. In that case some 425 metric tons of coal would have to be gasified in a day, requiring about 30 producers of the usual size, with revolving grates, and housed in a building about 500 feet long, with all the accessories, pipe lines, by-product recovery plant, etc., an undertaking entailing a large outlay, which only bolder spirits would care to tackle. The aim of the article is to show how, in many cases, the problem could be solved with a comparatively small outlay to pay for a few alterations in, and additions to, the existing plant making better use of the coke ovens, and of the blast furnaces to produce more gas. Modern coke ovens already work with by-product recovery plants, but they do not, perhaps, perform the work so well as do some of the more modern gas producer plants. It should be remembered also that the coals used for making blast furnace coke are the richest in the yield of by-products. Our aim, hence, should be to increase the coke output, which can easily be done in most cokeries. With blast furnaces, on the other hand, the case is different. They have originally been built for the greatest possible output, with the minimum amount of coke consumption. One of the chief cares of nearly every ironmaster is to keep down his coke bill. It will be difficult to induce him to drop this idea and to try to burn as much coke as possible in his furnace; in fact to turn his blast furnace into a gas producer. His objection that by altering the working temperature of the furnace, the quality of his pig iron would be spoiled does not hold water, as by suitably reducing the temperature of his blast he could work the furnace at the same temperature as before.

As an example, the author mentions his experience with a set of four blast furnaces, each of which when working with 100 per cent of coke and at a temperature of 700 degrees C. produced 350 tons of iron in 24 hours. The total consumption was therefore 1,400 tons of coke and the output 1,400 tons of pig iron. By changing their working in accordance with the suggestion broadly outlined above, i. e., by lowering the blast temperature to

500 degrees C., these same four furnaces actually produced 1,500 tons of pig iron of exactly the same quality as before in 24 hours, but consumed 1,650 tons of coke. Thus 100 tons more iron and more gas were produced, with 250 metric tons more coke. Now, if 1 pound of coke produces about 6.4 cubic feet of gas, some 3,528,000 more cubic feet of gas have been produced in the blast furnaces, and of a higher caloric value to boot, the author calculating the gain at about 1,500,000,000 calories, assuming an increase of 100 calories per cubic meter. This, he says, is a surprising result, considering that the calorific value of the extra coke used was only 1,750,000,000 calories, or only 250,000,000 calories more. The results, however, bear out his theory.

The author then works out a balance-sheet for the case under review under the new conditions. The extra input is 520,000,000 calories, the output 545,000,000 calories in round figures, proving that the temperature within the blast-furnace must have remained the same under the new fast as under the old "slow" working. Of the extra output of 1,750,000,000 calories due to the additional coke, 1,230,000,000 remained in the gas, but the increased calorific value of the gas was 1,500,000,000 calories. The difference of 270,000,000 an increase of 5.7 per cent, was therefore derived from the enhanced calorific value of the gas due to the more intensive working of the furnace. The result thus obtained, moreover, does not by far represent the whole of the potential progress in the indicated direction, and one may look forward to further developments.

It goes without saying—continues our author—that the extra gas has been produced in a cheap way. In the case under consideration, assuming a price of 18 shillings 6 pence per metric ton of coke or 231 pounds 5 shillings for the 250 tons, the cost of production works out at 0.27 pfennig per cubic m. (or less than a penny per 1,000 cubic feet.). The extra quantity of pig-iron produced was a great gain, insofar as its cost was practically covered by the costs of the additional ore and limestone, plus a small increase, say, of 7 per cent in the general charges, such as labor, etc. In the case of new works it would be possible to build the blast furnaces with higher stacks, to provide more powerful blowing engines, additional cleaning plant, etc., but the extra cost would not represent more than a fraction of the cost of a generator plant of the size outlined in the introduction of this article.



General view of Youngstown Sheet & Tube Co.'s plate mill, showing turnovers at left and center.

Novel Plate Turnover for Tandem Mill

Any Plate Within Limits of Mill Capacity Can Be Lifted from Inspection Table, Turned Over and Returned to the Table, in Same Space Originally Occupied With One Set of Cradles.

The new Youngstown sheet and tube plate mill is one of the most up-to-date of its kind and chief among its many distinctive features may be counted the plate turnovers which were designed and patented by William Forsstrom, chief engineer, of this concern. This installation is the first of its kind and experience has proved it to be capable of satisfactorily executing the duties for which it was designed. With this machine any plate within the limits of the mill capacity can be lifted from the inspection table, turned over and returned to the table in the same space that it originally occupied, all of this being accomplished in one operation and with one set of cradles. This contrasts very favorably with the old type of turnover which utilized one set of arms to lift the piece and a second set to lower it to the table in an overturned position and a transfer to bring the plate back to its original position, making three distinct mechanisms.

Great care was also taken to insure the accessibility of all parts, which is an important factor in operating and repairing efficiency. All parts of the turnover are above the table girders eliminating the necessity of dismantling the table regardless of the extent of the repair work being done.

The mechanism can best be described as a series of five turning cradles or forks, located between the table rollers and mounted on rack beams which are actuated by pinions mounted on a common driving shaft. This shaft is driven through a gear drive by a 40 hp. motor.

The forks are "V" shaped and are pivoted at the closed end which constitutes the bottom of the fork. At the open end or top of the fork each arm is connected by flexible links to stationary pins in such manner that when the fork is in an upright position in the center of the table, the links on both sides are taut.

The position of the turnover while receiving a plate is as follows. The pivot bearings on the racks to be at the extreme point of travel on one side of the table. Forks in a horizontal position, parallel with the rack beams, with the bottom arm below the top of the table roller. Flexible links of upper arm to be taut. Flexible link of bottom arm to be loose. In this position there are no obstructions to the free passage of plates down the table and they may, if desired, be passed through the turnover without being turned. In case the plate requires inspection on both sides the turning operation is accomplished by moving the rack beams, on which the pivot bearings are mounted, in a horizontal direction across the table. This moves the bottom of the forks in a horizontal line while the upper ends, limited by the flexible links are caused to describe an arc, bringing the forks from a horizontal position at the beginning of the stroke, to a vertical one in the center and thence to a horizontal position, directly opposite to the original one, at the end. This constitutes one turning operation and is performed by one forward or backward stroke of the rack beam, and leaves the turnover set to receive a new plate when the operation is reversed.

to accomplish the same result. The controlling equipment for the turnover motor includes, in addition to the master controller, a geared cut-out by means of which the motor is slowed down at a predetermined point near the end of each stroke by means of a shunted armature. This causes the forks which are descending to approach the table with a continually decreasing speed and finally come to rest without the shock which the momentum of the descending plate and cradles would ordinarily produce.

The general arrangement and plan of this mill was described in the July, 1918, issue of THE BLAST FURNACE AND STEEL PLANT.

The total floor space occupied by the plate mill buildings are approximately 210,000 square feet. The buildings are as follows:

The conveyor building is 80 feet wide by 250 feet long, and is in line with the mill and furnace building. It houses the conveying machinery, straighteners, turnovers, rotary shear and end-cut shear, and is equipped with a 10-ton single hook crane.

The warehouse is 93 feet wide by 320 feet long and is placed at the end of, and at right angles to, the conveyor building. It houses the trimming shears, circle shear, castor floor and shipping tracks, and is equipped with two 10-ton cranes with magnet drum.

The buildings are of steel construction and were furnished and erected by the Blaw-Knox Company, of Pittsburgh, Pa., much study being spent on the lighting and ventilation.

All of the buildings except the slab yard are built with the Pond type inverted monitor roof and equipped

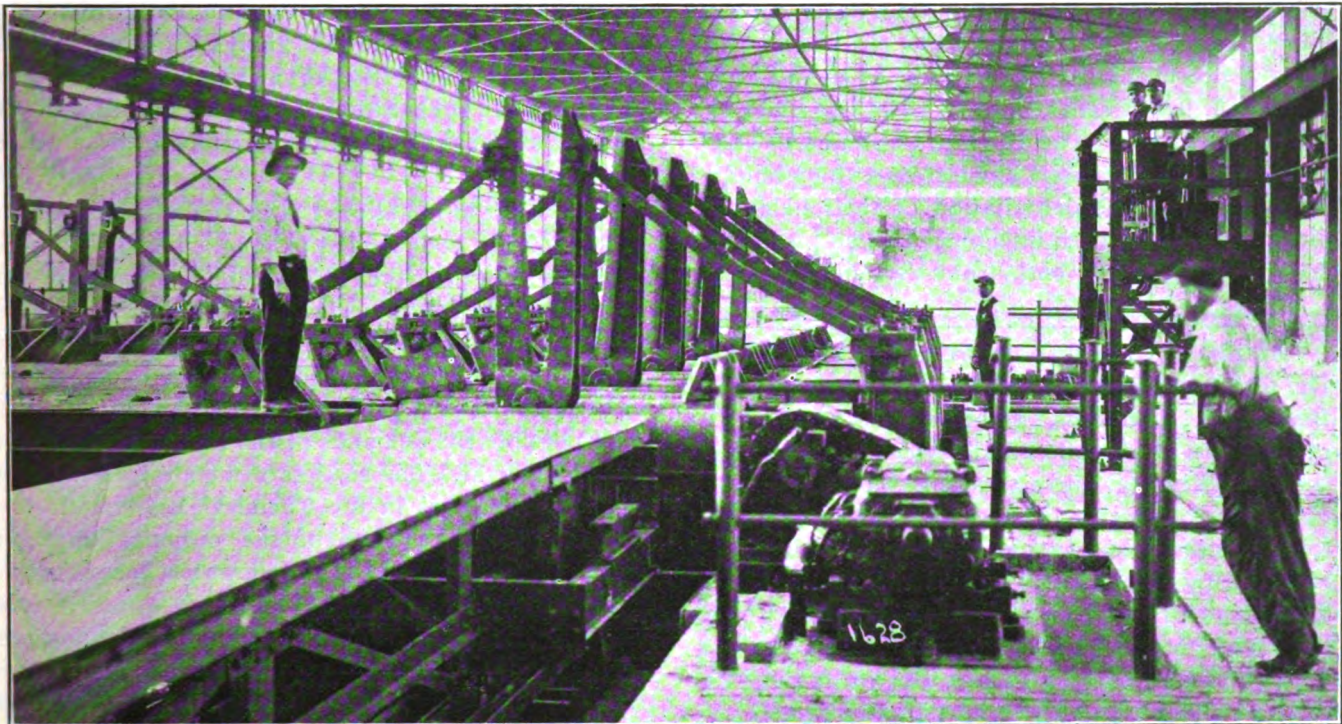


Plate turnover at Youngstown Sheet and Tube Company, plate mill. This device has replaced the usual arrangement of three mechanisms for doing the same work.

Mill and furnace building 80 feet wide by 300 feet long, which houses both mills and the continuous heating furnaces, and is equipped with a 40-ton crane with 15-ton auxiliary hoist and standard gage track for unloading materials.

The slab yard is 80 feet wide and 340 feet long and is equipped with two 10-ton single hook cranes with magnet drum and standard and narrow gage tracks for handling slabs. This building is built parallel with the mill buildings.

The motor room is 80 feet wide by 160 feet long, with brick walls, and is built parallel with the mill buildings. It houses the two 2,000-hp motors which drive the mills and all control equipment for them, and is equipped with a 20-ton single hook crane and standard gage track.

with Lupton top-hung sash and operates in the monitor, and with United Steel sash, furnished by the Trussed Concrete Steel Company for the side walls. The side wall sash consists of two runs of continuous sliding sash, each 5 feet high around all buildings, except the motor room, which building, having brick wall, is provided with ample pivoted ventilating sash.

The 40-ton crane in the mill building, and the 20-ton crane in the motor room, are of massive construction and were furnished by the Cleveland Crane & Engineering Company. The 10-ton cranes in the rest of the buildings are extremely high speed and are well adapted to the service which they perform. These cranes were furnished by the V. R. Browning Company.

Metallurgical Work of Bureau of Standards

A Review of the Research Work Concerning Welding, Tin Conservation, Bearing Metals, Protective Metallic Coatings, Sand Investigations, Etc., Conducted by the Bureau of Standards.

By G. K. BURGESS.

PART I.

The metallurgical work of the Bureau of Standards is carried out in laboratories of the Washington site, although there is some of the heavier engineering work in metals executed in the Pittsburgh laboratories. The scope of the work is limited mainly to problems in what has come to be called in recent years "physical metallurgy" in distinction to what we may call "chemical metallurgy" which was the only metallurgy of a few years ago. With this latter phase, including reduction of metals from ores and the processes concerned with the refining of metals, the governmental department charged with this field is the Bureau of Mines. The Bureau of Standards and the Bureau of Mines have always been in friendly relations regarding the delimitation of their fields in metallurgy and often work in coöperation on problems which are to be treated both from the chemical and

made of all facilities of the bureau in focussing the productive endeavors on the solution of any problem which may comprise many aspects of the subject. There is, for example, a division of structural materials, to which is entrusted the determination of many of the so-called physical constants of metals, including strength, ductility and hardness. The Metallurgical Division proper is divided into five sections: (1) the microscopic examination of metals, (2) heat treatment and thermal analysis, (3) physical and miscellaneous properties of metals, (4) foundry, (5) metallurgical preparations. The technical staff consists of 32 persons distributed among these various sections.

The work in metallurgy is housed in two floors of a building 74 ft. wide by 184 ft. long. This building was provided out of the President's emergency fund. Previously the Metallurgical Division had been housed in very inadequate quarters. The expanding into the larger building has enabled the bureau to meet in a very much better degree than it would have been otherwise possible the demands of the military departments during the war. The section of metallurgical preparations has quarters in the Chemical Building.

The general scheme of the organization of the metallurgical laboratory is as follows: (See sketches on opposite page.)

The plan laid down is, to be able to make any metal or alloy, give it any desired thermal and mechanical treatments, and carry out any required test or investigation of its properties. The manufacturing scale adopted, up to quarter ton units, appears sufficient to warrant reaching "practical" conclusions.

The basement of the Northwest Laboratory contains the manufacturing units, comprising foundry, heat treating and mechanical plants, which last includes motor-driven rolling mill with 4:1 speed control, 150-ton steam hydraulic power press and shearing attachment, driven by 150 hp air compressor, a motor driven 10-ton chain drawbench with attachment for drawing tubes, and shop, with a 10-ton crane over all. The foundry includes both gas and oil fired crucible furnaces, two of 200 and one of 50 pounds capacity, core ovens, moulding equipment, casting pits, etc.; a 150 kva arc electric melting furnace of 600 pounds capacity is being installed, and it is hoped to be able to install a 1 or 2-ton open hearth furnace. There is a laboratory attached to the foundry for research work on sands.

In this article and another one next month Dr. Burgess explains the functions of the Bureau of Standards, describes the equipment under its direction and reviews some of the metallurgical investigations conducted during the past year. A most valuable service to the industries of this country is being rendered by this institution, and the size and diversity of the investigations conducted bear testimony to this statement. In this article the equipment and field of the Bureau is described. The review of the investigations will appear next month.

physical standpoints. The Bureau of Standards is mainly concerned with the question of manufactured products and the determination of constants of metallurgical interest, and insofar as necessary the production of such materials on which experimental work of the determination of these constants is to be made. A very considerable amount of work also is done on the question of the drawing up of specifications for metals and articles of metal manufacture, in particular, for the government, or in coöperation with committees of the national societies interested. The work on metals at the Bureau of Standards is not confined to the Division of Metallurgy, but for convenience where the apparatus exists in another department for the determination of constants, as, for example, electrical, magnetic, thermal, linear expansion, etc., use is freely

The heat treating plant comprises one semi-muffle oil-fired furnace 7 ft. X 2 ft. X 1½ ft.; with quenching tanks of oil and water, 12 ft. X 3 ft., provided with circulation pumps; salt and metal baths; case hardening furnace; several gas and electric muffle furnaces of various sizes; five electric resistance tube furnaces; two electric melting furnaces for high temperatures; and there are being installed two large 50 kva electric annealing furnaces to serve the rolling mill; one of these 14 ft. long is designed for rods and tubes, and the other for ingots. Additional furnace equipment for special researches includes two high temperature vacuum furnaces with pumps, rheostats and other accessories and a number of small furnace units.

For thermal analysis there is an Einthoven galvanometer outfit, which will be used in various experiments on the properties of rapidly cooled alloys. This section also possesses three complete sets of thermal analysis outfits and has recently designed and put into operation a new type of furnace determining transition points in alloys. New apparatus for determining electrical resistance of alloys has been installed and considerable auxiliary apparatus and supplies purchased, including porcelain, platinum, quartz, thermocouples, galvanometers, resistances, tools, etc.

Among the miscellaneous equipment an optical pyrometer including a micropyrometric outfit, apparatus for determining hardness with Brinell and scleroscope, also new microhardness instruments are being designed; a 10,000-pound testing machine; a 30 ft. lb. impact machine. (The heavy mechanical tests are made by the structural materials section).

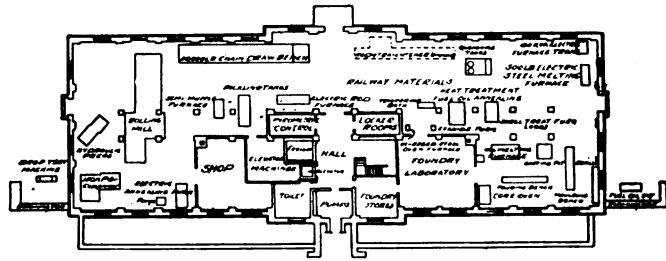
There is one room fitted up for physico-chemical research, electro-chemical analysis, and equipment for examination of fusible plugs. In addition to the general shop facilities of the bureau there is attached to the metallurgical division a small shop containing saw, grinder, miller, drill press and lathes. The electrical equipment for so much special apparatus is necessarily quite extensive and embraces several power lines with ac and dc and a flexible set of transformers, rheostats, potentiometers and other instruments, etc.

The metallographic facilities include adequate apparatus for cutting up, grinding, polishing, etching and photographing metals. The laboratory possesses three metallographic outfits, a Zeiss, Leitz and latest Bausch and Lomb model, and a varied assortment of accessories.

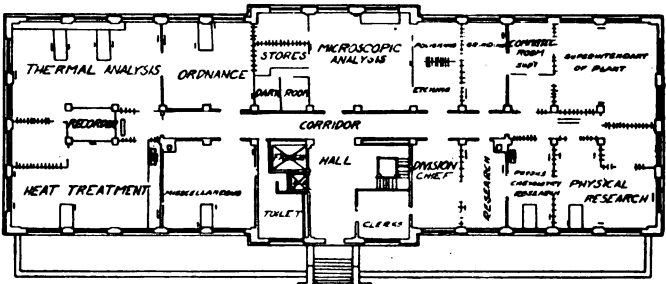
In the laboratory of chemical metallurgy are large electric vacuum furnaces and auxiliaries for preparing pure metals; an outfit for electro-deposition of iron, etc.; furnaces and other equipment for preparing pure magnesia crucibles; apparatus for determination of gases in steel, several for rapid determination of carbon by composition and electrolytic method; furnace

for preparation of pure aluminum; in addition to the usual chemical equipment.

During the period of the war the work of the metallurgical division, as well as of the rest of the bureau, has been mainly oriented about the specific requests of the various military departments for advice and experimental studies on the various urgent problems that have come before them, or, in other words, the metallurgical division, has been a consulting experimental laboratory to the military departments and has largely suppressed its own initiative during that period, and in consequence, of course, many of the problems which were under way at the outbreak of the war have been held in abeyance, although contact has by no means been lost with the many industrial interests which in normal times make very considerable use of the bureau. Without going into great detail on any of the actual problems which have been studied during the period of the war, mention may be made of several of the lines which have



Basement plan.



First floor plan.

been followed intensively. Light aluminum alloys; failure of brass; corrosion of non-ferrous metals; and aluminum and cadmium solders have been given especial attention.

Arc Welding.

In coöperation with the electric welding committee of the Emergency Fleet Corporation, an extensive program of investigation and tests of arc welds of ship plate has been undertaken. Besides usual metallographic tests, a special study will be made of the causes of brittleness in such welds and of the means for producing sound welds. This work is just beginning to get under way, and materials and welded specimens are being furnished by manufacturers.

Generated on 2024-09-08 14:05 GMT / https://hdl.handle.net/2027/chi.096839463 Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Improvement Made in Gas Reversing Valve

Wellman-Seaver-Morgan Company Develops Valve Similar in Principle to Forter Valve With Operating Mechanism Outside of Casing—Rapid Reversibility by Balanced Hood and Counterweight.

In the operation of any gas fired furnace, it is highly desirable that the valve controlling the direction of the flow of gas shall operate rapidly and easily. These factors have been kept in mind in designing the new W-S-M Gas Reversing Valve which has just been placed upon the market by the Wellman-Seaver-Morgan Company of Cleveland, O. That the conditions have been ideally met is evidenced by the fact that a 36-inch hand operated valve can be reversed in from 3 to 7½ seconds with a pressure of not over 25 pounds. This is accomplished by a perfectly balanced hood and counterweights.

An equally important feature is that, in this new design, the operating mechanism is outside of the casing where it is easily accessible and always cool. This new valve is similar in principle to the well

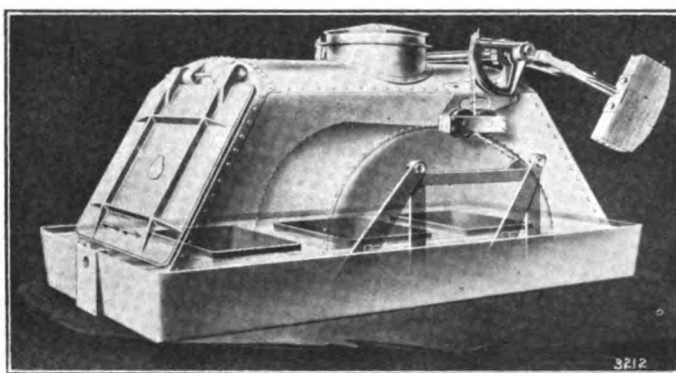
The base pan holds a quantity of water so that when the hood is over the ports a water seal is formed to prevent the escape of gas. The base pan has a tapped hole at each end for a water pipe. There is a perforated strainer at the intake end and a dam plate at the other end to hold the water at such a level as to allow the hood to extend three inches into the water forming the seal.

The outer casing is made of steel plate and lined with firebrick. It has cast iron door frames and door at each end through which the hood may be removed or inserted. Each door has a small peep hole with a swinging cover which enables inspection at any time. On the top of the casting is a cast iron neck which connects either with the fuel gas flue or the air intake, depending upon the purpose for which the valve is used.

The hood is moved by a series of levers and coupling shafts which extend through the water under the casing and into sockets on the hood. The shafts move on chilled iron bearings. The operating mechanism is actuated by a hand lever as shown in phantom view.

With all hand operated valves, a special stand is furnished as well as six sheaves with hangers, clamps and wire rope. The diagram shows the connections for the operating mechanism. At each side of the valve is a counterweight attached to an arm and sector over which passes a chain connecting with the supports of the hood. The form of this sector is such that the counterweights balance the weight of the hood at any position. The W-S-M valve has the following distinct advantages, the combination of which will be found in no other valve used for reversing the gases of melting or heating furnaces. The semi-elliptical form of the hood allows free flow of the gas, as there are no abrupt turns or constricted areas in the passage formed by the ports and hood. This feature is very important in obtaining maximum efficiency from the stack draft. All leakage or waste of gas is prevented by the water seal. Such a seal does away with all packing, tightening, and adjusting, the only attention required being the flow of a small quantity of water into the bed plate to replace the amount evaporated.

Due to its compactness, the W-S-M requires comparatively little floor space and adapts itself to various arrangements of flues from the regenerators to the stack. The weight of the hood is counterbalanced by the weights of the lever arm in such a way that the hood is in balance at any position.



Phantom view of gas reversing valve.

known Forter valve and is interchangeable as to ports and clearances. The general design and construction of the W-S-M valve are clearly shown in the phantom view. It will be seen to consist of an outer casing, a base with three ports, a hood to connect two ports, and the operating mechanism.

The center port is connected to the chimney. Waste gases from the furnace flow from whichever outside port the hood is covering to the chimney port. This leaves a clear passage for the fuel gas or the air entering the casing through the mushroom valve at the top to pass through the third port to the furnace regenerator. Reversal of the flow of gas or air is accomplished by moving the hood to a position over the center port and the one previously uncovered.

The base of the valve is a cast iron rectangular pan with three walled circular openings or ports. The hood which covers the center and one end port is semi-elliptical in form and made of steel plates with angles at the bottom to support a firebrick lining.

Does Forging Increase Specific Density?

Experiments Show That Little or No Change in Density Occurs During Forging on Steel Initially Free from Cavities—Ten Ingots of Basic Open Hearth Steel Used.

By H. E. DOERR.

The writer has been unable to find much information relative to tests made to determine the effect of forging on the specific density of steel. The opinion, however, among men engaged in the business, seems to be that forging greatly compresses or consolidates the steel. While such is doubtless the case with spongy or porous steel, the following experiments indicate that there can be little or no change in the density with steel initially free from cavities.

Ten ingots of basic open-hearth steel cast were used in the experiments. All the specimens were 0.53 carbon with all other elements the same, the analysis being determined from drillings taken midway between the center and outside of the upper end. The specimens were selected from over 1,000 ingots so

the ingots and numbered. The 10 pairs of specimens were submitted to Louis E. Endsley, Professor of Railway Mechanical Engineering, University of Pittsburgh; A. N. Talbot, Professor of Applied Mechanics, University of Illinois; L. Z. Slater, chief chemist, Scullin Steel Company, St. Louis, Mo. No information was furnished as to which specimens were forged or unforged and each laboratory used the same specimens, submitting the average of three independent determinations, a tabulation of which is shown in the accompanying table in which the laboratories are designated by the letters A, B, and C. While there is considerable difference in the individual determinations for a number of the specimens, the averages for both the forged and unforged specimens are very

Effect of Forging on Specific Density of Steel.									
Density Determined by Laboratory					Density Determined by Laboratory				
Specimen	A	B	C	age	Specimen	A	B	C	age
No. 1 forged	7.807	7.86	7.826	7.831	No. 7 forged	7.808	7.84	7.840	7.829
No. 1 unforged	7.732	7.81	7.815	7.786	No. 7 unforged	7.694	7.77	7.791	7.752
No. 2 forged	7.825	7.85	7.824	7.833	No. 8 forged	7.828	7.85	7.863	7.847
No. 2 unforged	7.756	7.79	7.792	7.779	No. 8 unforged	7.759	7.79	7.809	7.786
No. 3 forged	7.810	7.85	7.818	7.826	No. 9 forged	7.818	7.84	7.854	7.837
No. 3 unforged	7.779	7.79	7.781	7.783	No. 9 unforged	7.755	7.78	7.798	7.778
No. 4 forged	7.837	7.84	7.875	7.851	No. 10 forged	7.820	7.85	7.873	7.848
No. 4 unforged	7.774	7.80	7.790	7.788	No. 10 unforged	7.807	7.86	7.835	7.834
No. 5 forged	7.828	7.86	7.829	7.839	Average of forged.....	7.821	7.849	7.845	7.838
No. 5 unforged	7.802	7.83	7.800	7.811	Average of unforged.....	7.762	7.798	7.803	7.788
No. 6 forged	7.830	7.85	7.846	7.842	Increased density of				
No. 6 unforged	7.761	7.76	7.814	7.778	forged, per cent.....	0.76	0.65	0.54	0.64

that the tests could be comparative for the work done in forging only, but no two of the ingots were cast in the same heat. Each ingot remained in the mold approximately 30 minutes, when it was removed and air-cooled. About 12 hours later, when the temperature had been reduced to approximately that of the surrounding atmosphere, the head was discarded and the ingot heated in an oil furnace to approximately 2,250 degrees F. (1,235 degrees C.) Approximately 1 minute was required to forge under the steam hammer to 1¼ in. (31.75 mm.), rough diameter. All ingots were allowed to air-cool after forging. Cylinders ½ in. (17.7 mm.) in diameter and ½ in. high were then turned from the forged and unforged parts of

close. The determinations of each laboratory indicate that the forged is the denser of each pair with the single exception of "B's" determinations for No. 10. Assuming that all cavities, however small, were completely closed, the average results indicate that only 0.64 per cent of the sectional area of the original ingot consisted of cavities.

The ratio of volume to superficial area is so great with an ingot of the size used that it is doubtful whether the ingot can properly solidify without the formation of microscopic cavities. Undoubtedly, with large ingots where the ratio of volume to superficial area is smaller than with the ingots used, the percentage of increase in specific density of the forged specimens would be reduced to a negligible value, if not wholly eliminated.

Paper read before February meeting of A. I. M. E.

Heating Furnaces and Annealing Furnaces

Discussion of "Furnace Constant"—Curves Show Values for the Rate of Heat Abstraction from the Exterior of the Furnace. Appendix Shows Method of Computing Values for Curves.

By W. TRINKS.

PART III.

In the great majority of works using both heating furnaces and steam boilers there is a vast difference between the efficiency of the boilers and that of the heating furnaces. In the case of the boiler, efficiencies vary from 60 to 85 per cent, while in the case of the heating furnace, efficiencies range between 5 per cent and 20 per cent, as a rule, although much higher efficiencies have been obtained in a few isolated cases. By efficiency is meant (referring to the heating furnace) the ratio of the heat imparted to the steel to the potential heat in the fuel used. In order to give the reader an estimate of relative quantities of fuel consumed at 10 per cent, 25 per cent and at 40 per cent efficiency of furnace, I have inserted Table I.

Table I.

Quantity of fuel required to heat one ton (2,000 pounds) of steel from 100° degrees F to 1,400 degrees F, and from 100 degrees F to 2,200 degrees F.

Final temperature (starts from 100° F.)	Furnace efficiency, per cent	Fuel Consumption per ton of steel			
		Pounds of coal of 13,000 Btu per pound	Cubic feet of natural gas at 1,000 Btu per cubic foot	Cubic feet of coke oven gas at 525 Btu. per cubic foot	Gallons of oil at 144,000 Btu per gallon
1,400	10	369	4,800	9,150	33.4
	25	147	1,920	3,640	13.35
	40	92.5	1,200	2,290	8.34
2,200	10	562	7,300	13,900	50.7
	25	225	2,920	5,560	20.3
	40	140	1,825	3,480	12.68

*In the case of producer gas add 25 per cent to the coal consumption on account of losses in the gas producer.

At first thought it might appear as if the owners of heating furnaces and boilers had concentrated all of their energy on making boilers efficient, and had shamefully neglected heating furnaces. But a more careful inquiry shows that they have merely followed the path of least resistance. In boilers the heat absorbing medium has a temperature of 350 degrees F, while in heating furnaces it has at times a temperature reaching 2,200 degrees F. And since the gases of combustion which heat the steel, must leave at a temperature higher than that of the steel being heated, these gases carry away with them almost all of the heat produced by combustion, giving up only a very small fraction of that heat to the steel. This

condition cannot be avoided, unless expensive furnaces are installed in which the heat of the high temperature flue gases is utilized in some manner. As a rule, manufacturers shy at the great initial expense. In addition, experience has shown that the expensive high class furnaces must be properly operated, if the desired efficiency is to be obtained, and correct operation necessitates the employing of well paid attendants. As previously stated, the path of least resistance is that of installing simple, low priced equipment, of employing low priced help, and of working the furnace at low efficiency.

For the sake of a clear understanding of the movement of heat in a furnace, study Fig. 17. The flame travels from left to right. Travel of heat into the steel, see arrows (1) is desired. While heat travels in the direction (1), it also travels out through the furnace walls and the hearth, see arrows (2) and heat is lost in the flue gases, see arrow (3). During the process of heating an ingot or a billet, the relation between the quantities of heat (1), (2), and (3) is ever changing, so that it is difficult to get a clear view of the amount of fuel which must be burned for heating the steel. To get that clear view of the situation, we make an assumption which is near enough to the truth to give substantially correct results. We assume that the whole furnace interior is maintained at the temperature to which the steel is to be heated. It will readily be seen that in reality the furnace temperature is depressed when cold steel is put in, but that the drop in temperature is not great.

This simplification opens up the way to a comparatively easy calculation. Heat loss through walls and hearth, see arrows (2), goes on all the time, and fuel must be burned continuously to make up for this loss. The quantity of fuel which must then be burned in unit time (usually per hour) to maintain a hot furnace is called the "furnace constant" by some furnace engineers. Evidently this quantity is made up of two factors. Since fuel must be burned under this assumption solely for the purpose of keeping the furnace hot, the "furnace constant," or the no-load fuel consumption must be directly proportional to the heat loss (2) through the walls and hearth. For that reason, the heat loss just mentioned must be known before the no-load fuel consumption can be computed. Second, this later quantity depends upon that fraction

of the heat of combustion which is given up to the furnace walls. If the temperature of the latter be low, a large fraction of the heat is given up. If the wall temperature be high, a large fraction of the heat of combustion "goes up the flue." Furthermore, the correctness of the combustion process has a great influence. If much excess air is used the stack loss is great because the heat is distributed through a larger mass of gases. If not enough air is used, unconsumed fuel will pass out through the stack and make a flame at its top.

The two subdivisions of the problem of computing the "furnace constant" will now be taken up. Heat losses through the wall depend upon the size of the furnace, the furnace temperature, the thickness of the walls, the material of the walls, and upon heat abstraction from the outside of the furnace. On account of the large number of variables, a truly scientific calculation of the heat loss through the walls is too complicated for practical purposes. For that reason, average values for the rate of heat abstraction from

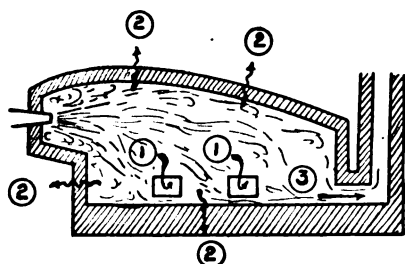


Fig. 17.

the exterior of the furnace wall must be used. Figures 18, 19 and 20 are offered as the nearest approach to a practical solution so far published. The curve of Figure 18 gives the heat loss in British thermal units per square feet and hour as a function of the external wall temperature on the basis of 60 degrees being the temperature of the surroundings. This heat loss has a value which is comparable to the heat loss of bare steam pipes; it must be higher than the figure given for steam pipes, because in the case of the latter we usually assume that the outer skin of the steam pipe has the temperature of the steam, whereas the skin temperature is lower than that of the steam. The curve shown in Figure 18 was used as a basis for computing the curves of Figures 19 and 20. The former shows the temperature of the outer surface of the furnace wall for given wall thicknesses, as a function of inside wall temperature. The latter shows the heat losses for the same conditions.

These curves are based on what data are now available. Further research may modify them to some extent, but the data offered will do away with so much blind guesswork that they may well be depended upon for practical use. The influence of a good insulating material such as sil-o-cel is very evident. For composite walls, including sil-o-cel, two curves

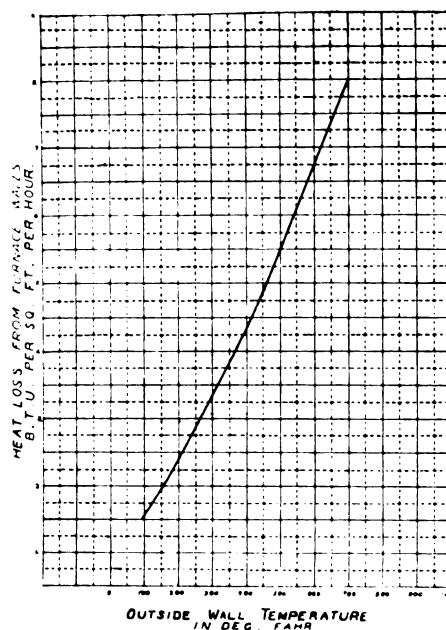


Fig. 18.

are given. The lower curves are based on data furnished by the Celite company. Very careful tests recently made by the Bureau of Mines indicate that the conductivity of sil-o-cel is about $\frac{1}{4}$ of that of firebrick, while Searle in his book on refractories gives the conductivity of kieselguhr (similar to sil-o-cel) as $\frac{1}{2}$ of that of firebrick. The upper curves for composite walls are based on the values obtained from the Bureau of Mines.

The use of the curves will now be illustrated by an example. Let us study the heat loss from a furnace with a heating chamber 4 ft. by 6 ft. by 3 ft. and with walls 9 inches thick. Let the inside temperature of the furnace walls be 1,800 degrees F. The heat loss per square foot and hour is found to be 1,280

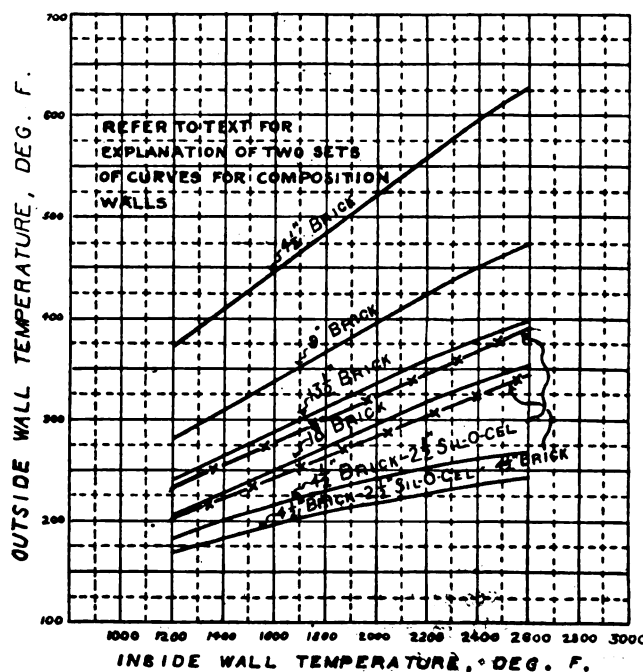


Fig. 19.

Btu, from curve sheet Figure 20. Take the heat transmitting surface half way between inside and outside, then the extent of that surface is equal to $2 (4.75 \times 6.75 + 4.75 \times 3.75 + 6.75 \times 3.75) = 150$ square feet. In consequence, the heat loss equals $150 \times 1,280 \times 192,000$ Btu per hour.

In practice, conditions are not as simple as indicated in the example. As a rule, the wall thickness is not the same all around. There are doors, observation holes, burner openings, and flue openings. And finally, there may be combustion chambers with higher temperatures than the rest of the furnace has. However, these varied conditions present no difficulty because they simply mean the calculation of the sum of different heat losses, each of which can be easily computed by means of the curves of Figure 20.

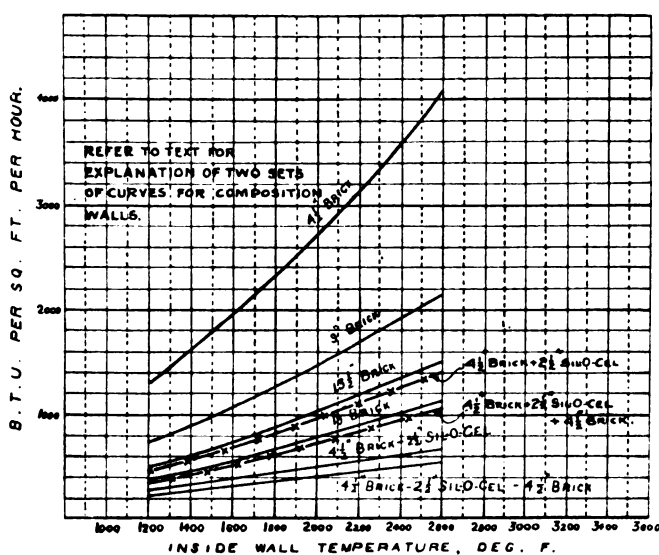


Fig. 20.

There are, however, two features in the calculation of heat losses which need further explanation. One is the transfer of heat through deep unventilated hearths, and the other is the radiation from openings in the furnace or from unprotected hot spots.

The former problem, namely, the heat loss through the hearth, may be approximated from Figure 21. The dotted lines show the general character of surfaces of equal temperature (contour lines), while the solid lines indicate flow lines or stream lines of heat. The wavy lines are heat flow lines of average length. The latter may be considered the equivalent thickness of a wall of firebrick. The length of the wall may be taken equal to the curved, dotted line a-a. The temperature at point F, that is to say, at the hottest place of the foundation, may be found from equality of temperatures at points F (foundation), H (hearth), and W (wall) in this manner: From curve sheet Figure 19, we find the temperatures of the outside of the wall for the side wall, and for a wall of thick-

ness equal to the length of the wavy line. The temperature drops steadily on each case from the inside to the outside. If, for instance, point W is halfway

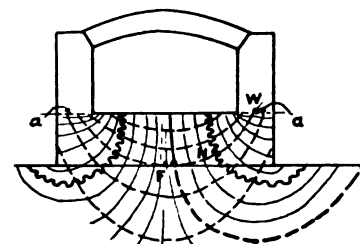


Fig. 21.

through the wall, then its temperature is halfway between the inside and the outside temperatures. It will readily be seen that the temperatures at point F can reach very high values (too high for a concrete foundation), if the furnace is wide and the brick hearth thin.

The second problem, namely, the heat loss by radiation through openings, is likewise amenable to calculation. In Figure 22, let HH be a hole in the furnace wall. Then the eye E of an observer, no matter where located, can see the interior of the furnace just as if that interior were a plane surface located at HH and having the extent HH. In consequence, the problem is boiled down to finding the radiation from the surface HH. Evidently this radiation is smaller than if the hot surface were located at LL, and the question is: How much smaller? A correct answer is not easily given on account of the complexity of heat flow, but again we can reason matters out and by the use of some judgment, obtain fairly reliable results by simple means. In Figure 23 the radiant ideal surface HH has been redrawn to a larger scale. Evidently, the temperature of the walls between H (inside) and L (outside) will drop somewhat as indicated by the ordinates between the curve KL and the base line HL. The ideal surface HH radiates to the walls HL, and they in turn radiate through the hole LL. To take care of this situation we may replace the

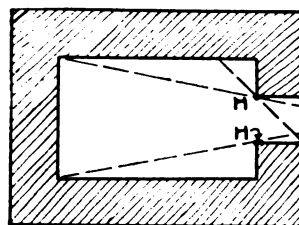


Fig. 22.

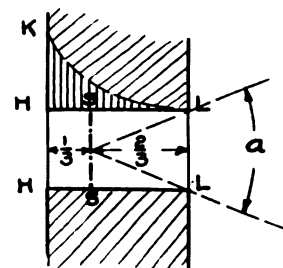


Fig. 23.

ideal surface HH plus the wall surface HL by a new equivalent surface SS located somewhere between HH and LL. For practical calculation I locate that

surface SS as indicated in Figure 23, namely, 1/3 of the way out from the inner wall, and then take (a) degrees of the black body* radiation of the surface SS. Slight modifications are required if the hole is of odd shape.

The black body radiation per square inch of surface SS is given by the curve in Figure 24. In this curve the temperature of the furnace surroundings was taken to be 100 degrees F. A brief calculation shows that considerable quantities of heat radiate away through small openings.

Appendix to Part III of Series of Articles on Heating Furnaces and Annealing Furnaces.

The following is an example showing the method used in the calculation of the curves shown in Figures 19 and 20:

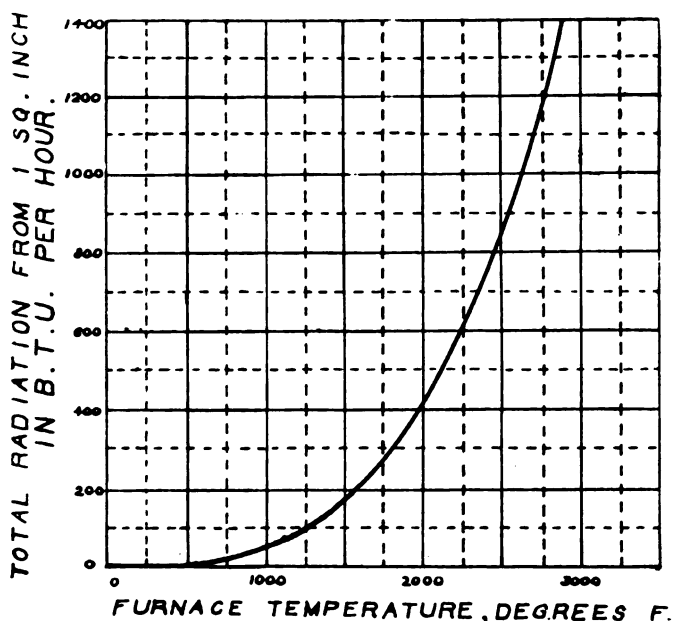


Fig. 24.—Black body radiation Btu per square inch per hour.

Let it be required to compute the amount of heat transferred in one hour through a furnace wall made up of 4½-inch firebrick, 2½-inch sil-o-cel, and 4½-inch brick. Base calculations on a temperature of inner side of wall of 2,600 degrees F., and a temperature of the outside air equal to 60 degrees F.

For the above conditions the heat transfer equation is,
 $K_c (t_1 - t_o) = K (t_o - t_a) = \text{Btu per sq. ft. per hr.}$

K_c = coefficient of conduction for the wall, Btu per sq. ft. per hour per degree F.

K = coefficient of radiation and convection from outer surface of wall to surrounding air.

t_1 = inside wall temperature in degrees F.

t_o = outside wall temperature in degrees F.

t_a = air temperature outside, assumed 60 degrees F.

*Radiation from the interior of an almost closed furnace is called black body radiation.

To determine K_c we have,

$$K_c = \frac{1}{\frac{w_1}{K_1} + \frac{w_2}{K_2} + \frac{w_3}{K_3}} = \text{Btu per sq. ft. per deg. per hr.}$$

K_1 = coefficient for inner brick wall, and which equals 12.1 for the temperature range from 1,800 to 2,600 degrees F.

K_2 = coefficient for sil-o-cel wall, which equals 2.25 for the temperature range from 700 to 1,800 degrees F.

K_3 = coefficient for outer brick wall, which equals 6.4 for the temperature range from 100 to 700 degrees F.

It must be remembered that the conductivity of all refractory materials grows with the temperature. A first estimate of the probable temperature must be made, therefore, the actual temperature must be computed with the values of conductivity derived from said estimate. If the final values depart considerably from the estimated values, a new set of calculations must be made with conductivity corrected in the proper direction.

w_1, w_2, w_3 = thickness in inches of the three parts of the wall, respectively.

Therefore, the general coefficient becomes,

$$K_c = \frac{1}{\frac{4.5}{12.1} + \frac{2.5}{2.25} + \frac{4.5}{6.4}} = .457 \text{ Btu per sq. ft. per deg. per hr.}$$

$K = 3.75$ for an outside wall temperature = 340 deg. Accordingly, we now have,

$$.457 \times (2600 - 340) = 3.75 \times (340 - 60).$$

If the corrected value for t had been used, the above equation would have been an equality, as it stands now the left hand member equals 1035, and the right hand member equals 1050. Since the difference between the two sides equals 15 Btu it is necessary to make a correction, in which case it will be found that the rate of heat transfer through this wall with the above temperature conditions is about 1040 Btu per square foot per hour, with an outside wall temperature of 340 degrees F.

EDITOR'S Note—This is the third installment of this series of articles by W. Trinks on "Heating Furnaces and Annealing Furnaces." The series will be extended through the entire year. Reprints of the articles as they appear each month are available, provided request is made for them immediately following the publication of the issue. This series of articles will supply information forming the basis for answering the following questions:

1. How many furnaces and what capacity or size each furnace are required for a given output?
2. What fuel shall be used?
3. How much fuel shall be used for the given output?

Bound up with this question is the important problem whether cheap furnaces with high fuel consumption shall be installed, or whether preference is to be given to more economical furnaces with higher cost of installation.

4. How shall the material (which is to be heated or annealed) be handled mechanically?

5. How must the furnace be designed to stand up without excessive repairs?

Geared Versus Direct Coupled Motors

Flywheel and Motor Built in Single Unit With Direct-Coupled Drive Removes Care and Maintenance of Gear Although Having Slightly Higher Initial First Cost.

By R. W. DAVIS.

The question of geared versus direct coupled motors has frequently arisen in the electrification of rolling mills during the past year or two, and, as in all debatable questions, both types of drive have certain inherent advantages.

In the majority of rolling mill drives a fly wheel of greater or less capacity is desirable as a part of the

siderably larger than where the wheel is mounted on the mill shaft, since all shocks and loads imposed by the flywheels must be transmitted by the gear to the mill, and unless the gears are very liberally designed, this may result in a somewhat greater maintenance expense. Advocates of the geared drive lay considerable stress on the fact that the total cost of the geared equipment is

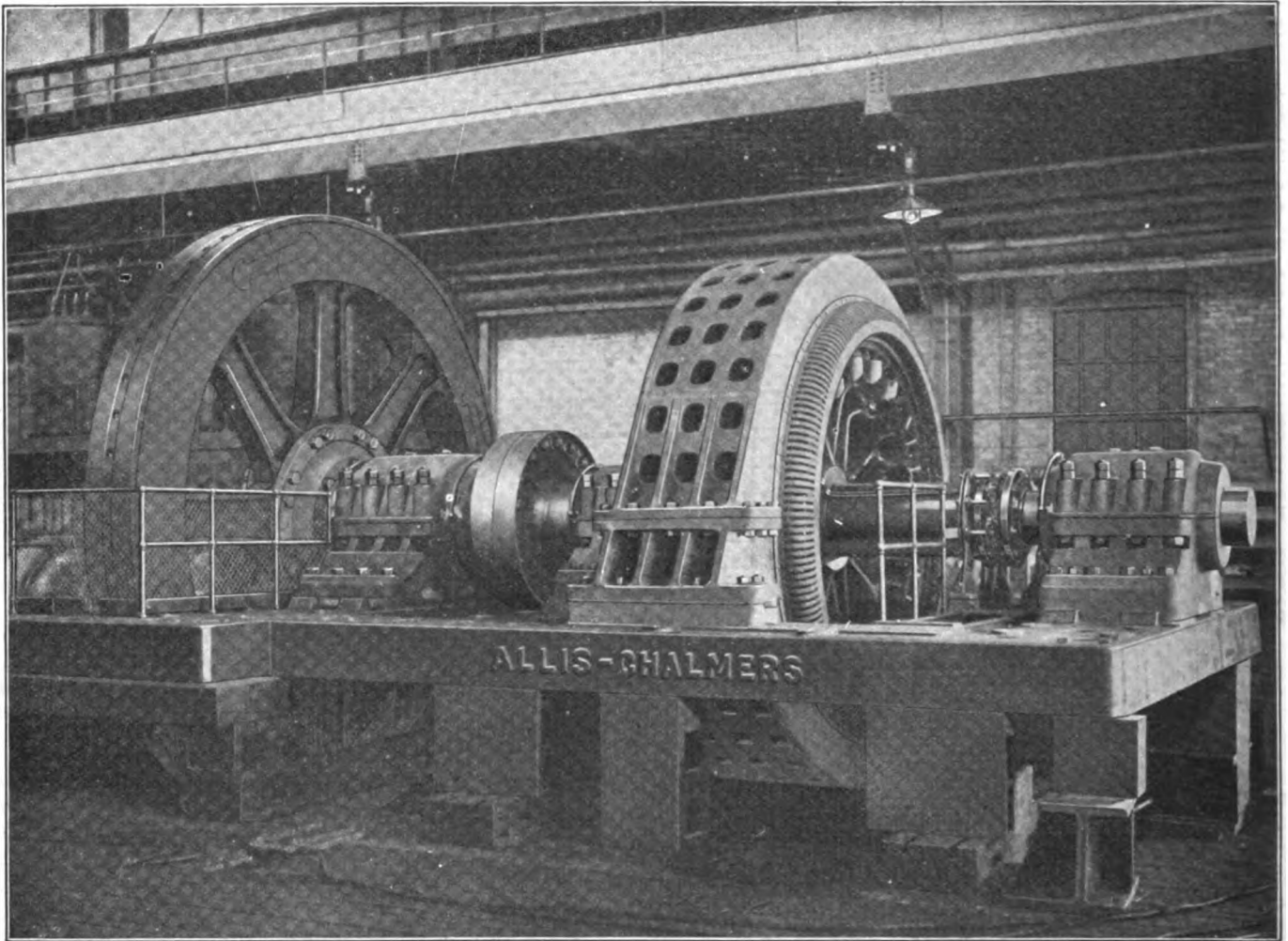


Fig. 1—2,000 hp, 81 rpm, 6,600-volt, 3-phase, 25-cycle motor—duplicate units used for tandem plate mill drive.

drive. Wherever gears are used between the motor and mill it is optional whether the fly wheel be operated at the mill or motor speeds. When operated at the mill speed it must, of course, be just as large as would be the case with the direct coupled unit. If operated at the motor speed, however, the flywheel may be mounted upon the motor shaft or else twin wheels may be used on the pinion shaft. In either case, the gear unit must be con-

somewhat less than of a direct coupled drive, especially if the flywheels be operated at the pinion speed where higher rim speeds can frequently be used to advantage.

The direct coupled unit appeals to many operators, as it does away with the care and maintenance of the gear, many operators contending that this saving alone justifies the slightly higher initial cost of the direct coupled equipment. Another distinct advantage of the

direct coupled unit is the fact that the flywheel and motor can be built as a single unit mounted upon a common bed plate as illustrated in Fig. 1. The necessary WR² may either be placed in the rotor of the motor or in a separate wheel as shown in the illustration. When placed in the rotor of the motor it frequently necessitates building the machine of larger diameter and greater weight than is best suited to the given rating. This usually results in a compromise solution where neither the materials in the motor nor fly wheel are worked to the best advantage. By building the wheel separate from the motor its rim speed can be made suitable to the material and weight of the wheel and the diameter of the motor

When direct coupled units are employed the pedestal bearing next to the mill should be of cast steel with a suitable thrust collar separate from the rest of the bush-

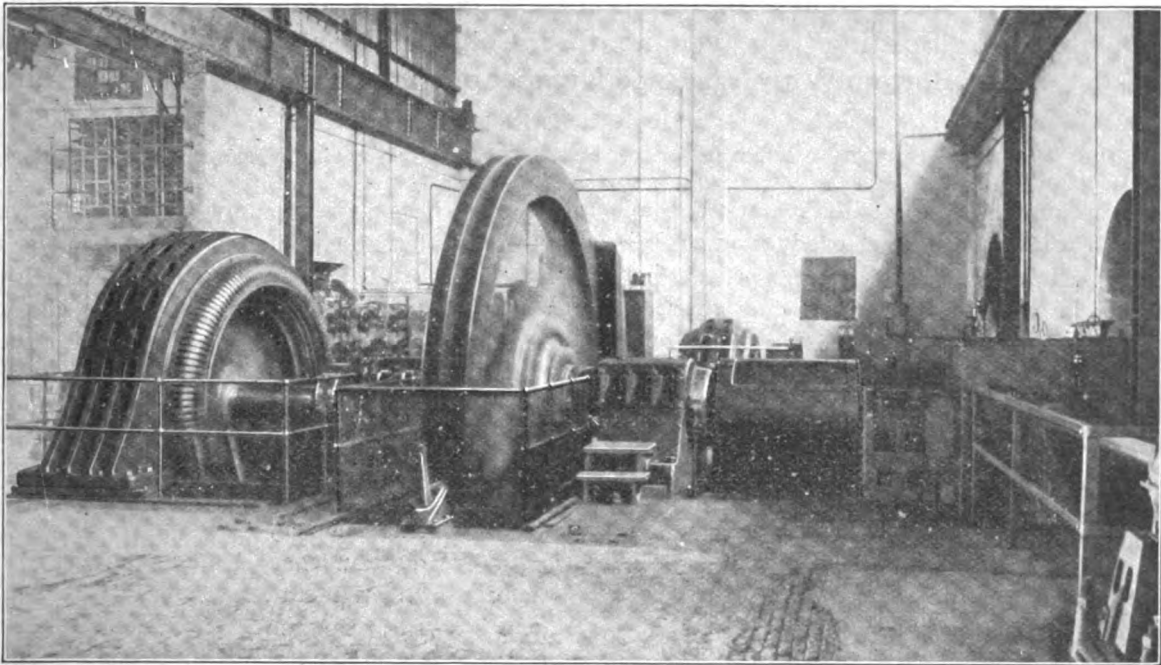


Fig. 2—1,500 hp, 150 rpm, 6,600-volt, 3-phase, 25-cycle motor driving roughing rolls of wire rod mill.

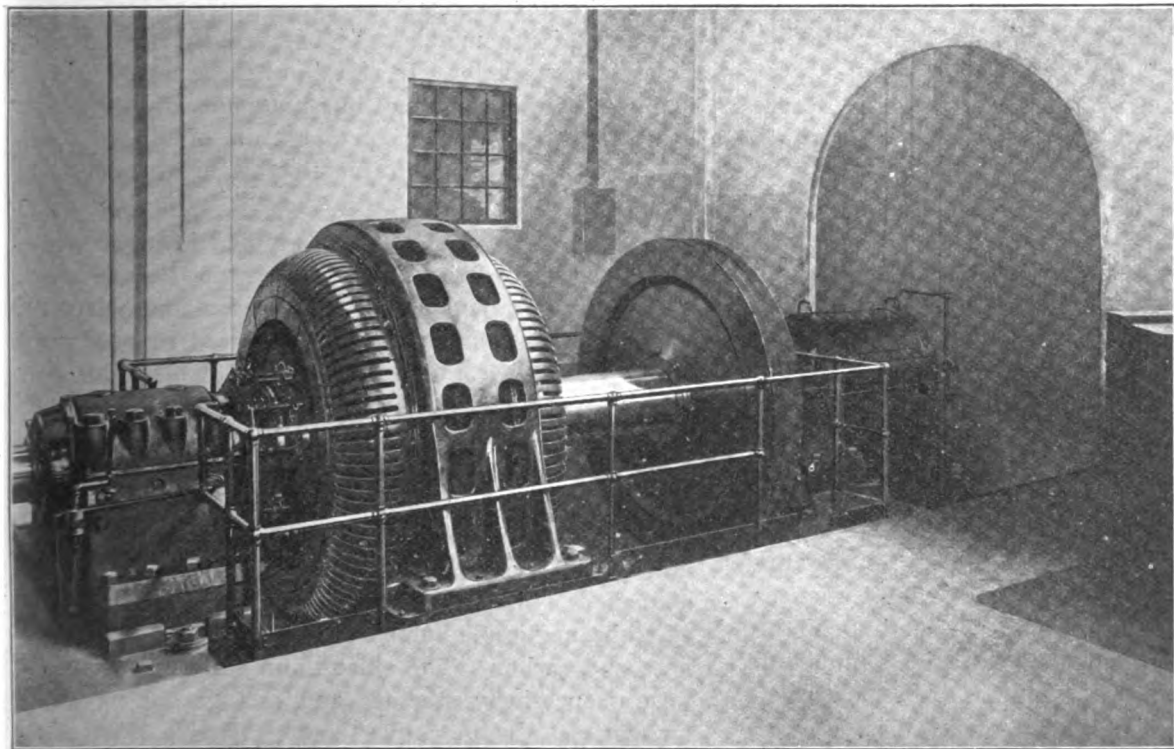


Fig. 3—2,400 hp, 500 rpm, 6,600-volt, 3-phase, 25-cycle motor driving wire rod mill.

can be made as small as the rating of the machine makes desirable. With this design the materials in both the fly wheel and motor are used to the best advantage.

ing. The whole bearing is designed to take the thrust of the mill in case a spindle breaks. The earlier designs provided a mechanical fuse to relieve the bearing of this strain. In this design the rotor moves away from the mill axially after the breaking of the mechanical fuse, thus clearing the broken spindle. It has been found in practice, however, that this application is not necessary and that it is perfectly feasible to make the thrust bearing sufficiently strong and rigid to withstand any thrust obtained from a breaking spindle. With the flywheel built separate from the motor, the motor and wheel may be mounted in 2, 3 or 4 bearings, as the weights and speeds may make desirable. These three constructions are shown in the accompanying cuts.

Generated on 2024-09-08 14:06 GMT / https://hdl.handle.net/2027/chi.096839463
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Present American Acid Bessemer Process

Reversibility of Manganese Oxidation Reaction—Eliminating “Spitting” by Temperature Control During Blow—New Style Bottom With Increased Number of Tuyeres and Reduced Pressure.

By RICHARD S. McCAFFERY,
Professor of Metallurgy, University of Wisconsin.

Bessemer's patent of 1855 marked the beginning of the great modern steel production processes of the world. The use of the Bessemer process spread fairly rapidly in the large steel producing countries, and for a great number of years most of the structural steel and railway rails were made in this way. In 1878 the Thomas Gilchrist patents were taken out and the basic Bessemer process developed on the continent and in England, but the United States continued to employ acid Bessemer, on account of the favorable situation here with respect to low phosphorus iron ores. With the increase in phosphorus contents of the ores, the basic open hearth process largely displaced acid Bessemer in the United States, but more recently, within the past 10 years, the duplex—a combination of acid Bessemer and basic open hearth—offered such advantages that interest has been very much reawakened in the possibilities of the acid Bessemer process itself. Many duplex plants have been built recently, employing larger converters than were attempted in the past, and, as a result, new problems of great technical importance have arisen.

Present American practice with large acid Bessemer converters is about as follows: The iron, which has been taken from blast furnaces in the molten condition and then poured into a mixer, is drawn, as required by the converters, from this mixer into a transfer ladle, and poured into the down-turned converter, which has a capacity of about 25 tons. The air blast is now admitted, the converter turned up, and the elimination of the silicon, manganese, and carbon is rapidly carried on. The blast pressure usually employed varies between 20 and 25 pounds per square inch at the converter, and if it be necessary during the blow to cool the converter contents, arrangements are made for the addition of scrap steel, or, in plants where scrap steel can more advantageously be sent to the open hearths, provision is made to cool the converter by blowing in steam with the air. The time of the blow depends on the amount of impurities eliminated, the design of the converter bottom, and the blast pressure; but generally, with a 25 ton vessel, it is between 10 and 15 minutes. When the contents of the converter have reached the desired carbon, or when soft blown, the converter is turned down, the blast cut off, and the vessel contents poured into a ladle.

Recently the writer had the good fortune to wit-

ness a great many Bessemer blows, and to take samples and temperatures at various stages of the blow with the object of determining if the reaction whereby the manganese in the pig is eliminated as oxide is a reversible reaction, and, if reversible, a possible method of keeping manganese in the blown metal, and also for the purpose of determining means of preventing “spitting” which takes place during the latter part of the Bessemer blow with certain irons, which “spitting” is very objectionable and largely increases production costs on account of the necessity of regular cleanups, to gather together the slag and metal ejected from the converter.

To determine the reversibility of the manganese oxidation reaction, a series of samples were taken of the mixer metal, the converter contents at the end of the silicon blow say, in four minutes from the start), in the middle of the carbon blow (say, in 8 minutes from the start), and of the soft blown metal. Slag samples were taken at the same time, and the temperature of the metal was observed by means of a Scimatco pyrometer. In certain of these tests residual manganese was obtained, but not generally, while in some of the tests, when a temperature of 1830° C. was obtained by the blown metal, the manganese was entirely oxidized.

In regard to the “spitting,” it had been observed that this was worse with a low silicon, high manganese pig, say about 1 per cent silicon and with $1\frac{3}{4}$ to 2 per cent manganese; and also that it was much worse the higher the temperature at which the converter was operated. After a study of all the data obtained was made, the following explanation seemed to account for all the difficulties, and suggested improvements in the practice. In the following discussion phosphorus is not considered, as it is not eliminated in the acid Bessemer process, and sulphur is neglected, as its effect on the heat balance is so small as to be negligible compared with the silicon manganese and carbon. The silicon and carbon of the iron form respectively silicides and carbides of iron and manganese. In the converter the carbides of iron and manganese may burn to form, in greater part, carbon dioxide if the temperature is low, and to form carbon monoxide, in greater part, if the temperature is high. The net heats of combustion in the converter of these carbides and silicides is figured below:

Substance	Formula	Oxidation Product	Calories per gram atom of metal
Silicide of Iron	FeSi	Fe ₂ O ₃ & SiO ₂	245
Carbide of Manganese....	MnC ₂	MnO—CO ₂	171
Silicide of Manganese....	Mn ₂ Si ₂	MnO—SiO ₂	135
Carbide of Iron.....	Fe ₃ C	Fe ₂ O ₃ & CO ₂	98
Carbide of Iron.....	Fe ₃ C	Fe ₂ O ₃ & CO	75
Carbide of Manganese....	MnC ₂	MnO & CO	35

They are arranged with the greatest heat of combustion first—in other words the arrangement is in the order that oxidation occurs, the silicide of iron burning first and carbide of manganese, when the carbon burns to carbon monoxide, remaining until last. It is assumed that the iron burns to magnetic oxide, as that reaction liberates most heat.

With this thermal data, the cycle of the acid Bessemer blow will be considered. The iron silicide first burns, forming magnetic oxide of iron and silica, and, as a result of the high combustion heat, the temperature of the converter rises. If the bath is not at too high a temperature now, the manganese carbide burns, the carbon becoming carbon dioxide. In this discussion I assume that iron silicide burns completely first, then the manganese carbide begins. This, however, is not the real condition. I believe all the reactions take place at the same time to a greater or lesser extent—only at one time some one reaction is taking place more rapidly than it does at other times—that it is predominating at some time over the other reactions; and when I say that one reaction takes place and then another reaction follows it, I mean it in this general way: That some one reaction is predominating at one particular time. The oxidation of the manganese carbide, at the lower temperature which we have assumed in the converter, produces manganese oxide and carbon dioxide, and the oxide of manganese, along with the magnetic oxide of iron, forms with the silica, previously produced, an iron manganese silicate slag. The temperature is rising right along now, and the iron carbide burns, and for this discussion it is immaterial whether the carbon of the iron carbide burns to carbon dioxide or to carbon monoxide. When the carbon of the iron carbide is burned out, and as the manganese carbide has been previously burned, the acid Bessemer process is then completed, the vessel is turned down and poured, and we have what might be called a normal blow, the temperature of the blown metal being between 1,600 and 1,650° C., and no trouble of any kind has been experienced.

With this normal blow, now contrast what takes place if the temperature of the converter is raised and the blown metal is excessively hot. We start in with this second blow and first burn, as before, the silicide of iron to magnetic oxide of iron and silica. The temperature of the mixer metal may have been higher or more silicon may have been in the pig; but, as a result, after the silicon of the iron has been burned, on account of the high temperature, the silicide of manga-

nese now burns and the manganese carbide remains in the molten metal. This manganese carbide now begins to cause trouble. It is a very active reducing agent, and it begins to reduce the silicon in the silica to metallic silicon and to reduce the magnetic oxide of iron to ferrous oxide, both of which results are detrimental, because the slag is made more basic, first by the reduction of the silica, and secondly, because the magnetic oxide may form with ferrous oxide or manganese oxide, a certain amount of ferrite slag. This possibility of ferrite formation is prevented by the reduction of the magnetic oxide to ferrous oxide. The net result of this increase of basicity of the slag is to render it more infusible, which again, results in the "spitting" phenomenon. This continues until all the manganese carbide has been eliminated by reducing silica and magnetic oxide. The iron carbide now oxidizes and the manganese carbide continues to reduce silicon until the manganese carbide is itself completely burned. Then, with the elimination of the carbon of the iron carbide, the blow is finished and the vessel turned down.

The answer can now be made to various questions proposed in the beginning of this paper as follows:

Is the reaction $2 \text{ Mn} + \text{O}_2 = 2 \text{ MnO}$ a reversible reaction at the temperatures possible in a Bessemer converter? It is not, because many blows were finished at 1820° C., or 200° C. above the normal temperature, and in these blows the manganese was completely oxidized. Then how about certain blows in which residual manganese was formed? In these blows, the silicon in the pig was always high, and silicon was always residual with the manganese, the explanation being that the early and middle parts of the blow were carried on at a high temperature, causing the manganese carbide to stay behind in the metal and reduce silica. In these latter blows the drop of the flame is not so clear and certain as in normal blows and when the iron carbide is completely burned the flame appears to drop somewhat and the converter is turned over. However, there is always sufficient carbon remaining in these blows to combine with the manganese, and the manganese in the blown metal is not residual from the reversibility of the oxidation reaction but from the presence of some manganese carbide, while the residual silicon in them results from the reduction of silica by the reaction of some of this manganese carbide.

The "spitting" can be cut down or entirely eliminated by temperature control during the blow, and, to secure this regulation, the steam line into the converters, experimented with was increased in size because scrap was not available to add to the hot charge to lower its temperature. By steaming during the silicon blow and thus keeping the temperature down the manganese carbide is burnt out early, its detrimental reducing action is prevented and the "spitting"

stopped. During the experimental work, under certain conditions, it was observed that the converter temperature rose rapidly during the carbon blow, which of course it should not do. This indicated the possibility that the carbon monoxide in the converter was being burned in the vessel to carbon dioxide, a result not desired, as it made the temperature higher, necessitating the use of steam or scrap, either of which increased the cost; and in addition more power was used in the blowing engines to furnish oxygen to burn the carbon monoxide in the vessel when the carbon monoxide might just as well have been discharged into the atmosphere and there burned.

With these considerations in mind, a new converter bottom was designed, increasing the number of tuyeres and changing their distribution, and a test was made of the new bottom in comparison with the old. On account of the difficulty of installing air measuring apparatus, the blowing engines, which had been previously indicated under various operating conditions both on the steam and air ends, were used as an air meter. Two consecutive pours from the mixer were blown so as to obtain, as nearly as possible, the same quality of metal; and these ladles were separately blown by the same blowing engine, with only the one engine on the blast main. Both charges were blown soft. The result follows:

Table 2.
Old style bottom. New style bottom.

No. tuyeres $\frac{5}{8}$ ".....	23	35
Wt. mixer metal.....	47,000 lbs.	50,000 lbs.
Blast pressure at engine..	28 lbs. per sq. in.	22 lbs. per sq. in.
Total engine rev's. per blow	589	443
Time of blow.....	14'-0"	10'-20"
Comparison of time.....	100%	69%
Comparison of power used	100%	60%

This test indicated the cause of certain of the troubles. As a result of the high air pressure employed with the old converter bottoms, large amounts of air were blown through the molten bath without oxidizing the impurities but, instead, burning the carbon monoxide in the vessel to carbon dioxide. In this case, as shown by the test, the time of blow is actually shortened, by reducing the blast pressure, equal to an increase in converter capacity of 45 per cent, with an actual saving in blowing power for the increased capacity.

Aside from this very obvious advantage, however, the reduction of the converter temperature and the control of the oxidation of the manganese carbide, with the elimination of "spitting," are other advantages of the greater number of tuyeres and reduction of blast pressure with the new style of bottom.

Some of the temperatures obtained for certain Bessemer blows seemed so high that great care was taken to make certain that they were correct. Two observers with separate instruments could obtain checks on the temperature with 10° C. easily, and usually were within 5° C. The instruments were standardized twice a day, and as the instruments gave normal readings for the normal blows there is no reason to believe that the high temperatures obtained for certain blows were incorrect.

At first glance it might appear that a comparatively old process like acid Bessemer does not offer many possibilities for research, but, after close study of the process, the need for and possibility of research becomes very apparent.

Prof. Richard S. McCaffrey published these findings in the January issue of *The Wisconsin Engineer*.

Manganese Alloys in Open Hearth Practice

Utilization of Domestic Alloys—High Residual Manganese Practice—Use of Manganese-Silicon Alloys in Acid Practice; Electric Furnace Practice and in Basic Open Hearth Practice.

By SAMUEL L. HOYT.

The War Minerals Investigation, Manganese Section of the Bureau of Mines has made a considerable investigation on the use of manganese alloys in the open hearth furnace. The results of these investigations were presented before the February meeting of the A. I. M. E., held in New York, by Samuel L. Hoyt. An abstract of the recommendations based on this investigation follows:

Recommendations for Utilization of Domestic Alloys.

As a result of this investigation, it is advanced that there are three practices for utilizing our domestic alloys in open hearth practice that commend themselves; they are as follows, but not in the order of their importance.

1. The use of a molten spiegel mixture for deoxidation and recarburization.
2. The practice of melting and refining the steel bath so as to secure a comparatively high residual manganese content, about 0.3 per cent manganese.
3. The use of manganese alloys containing silicon.

In selecting plants for investigating these practices, two points were kept in mind. The plant should have either "ordinary" practice, for the sake of comparison, or else one of the three just mentioned and the product or kind of steel made should be representative of the larger tonnages, such as shell steel, plates, sections, etc.

Molten Spiegel Mixture Practice.

The practice has been adopted, at a few plants, of combining in one operation both recarburization and deoxidation by using a mixture of pig iron and spiegel, which has been premelted in a cupola. This molten spiegel mixture contains from 5 to 11 per cent manganese, 4 per cent carbon, and the desired amount of silicon, and is added to the ladle during the tapping time in such a way as to get a thorough and uniform mixture of the two streams.

The principal advantages, not considering questions of plant and operating economy, are: A low grade or domestic alloy can be used in the preparation of the mixture. The deoxidation is accomplished by means of a dilute solution with a consequent increase (on theoretical grounds) of the efficiency of the deoxidizer; this point will receive further consideration later. The deoxidizer is added in the molten state, securing thereby the attendant advantages of this practice, which will be considered at greater length. The amount of the recarburizer is comparatively large and the capacity of the plant is materially (and economically) increased thereby;* this is an advantage if a large steel output is desired. Compared to the usual practice of adding carbon and manganese, there should be less likelihood of missing a heat.

This practice, at least at the plant visited and it is understood to be the same elsewhere, is limited to the manufacture of the high-carbon steels or those running 0.30 per cent carbon or above. To make steels with 0.20 per cent carbon would require the working of the carbon to about 0.10 per cent carbon and the molten addition would have to contain about 20 per cent manganese (spiegel). The amount of the addition would be reduced from 13,000 lbs. (5896 kg.) to about 4,000 lbs. (1814 kg.) which would mean that some of the advantages just enumerated would decrease in weight and with the increased loss of manganese would probably mean that the practice would no longer be commercially feasible. However, when the other alternatives, that is, the use of ferromanganese, either solid or liquid, is considered, the practice of premelting spiegel in the cupola would seem to commend itself as worthy of consideration. In case of undue shortage of high-grade ferromanganese, there can be no doubt but that the practice would offer a ready solution of the problem of using domestic alloys in making steel for shapes, plates, etc. Against the increased cost of production, compared to cold ferromanganese practice, there would be the greater uniformity of the product and the more uniform practice.

* There is some doubt as to the propriety of including this as an advantage of this particular practice. The use of pig iron as a recarburizer may be accomplished in other ways with the same economy and increase in plant capacity.

High Residual Manganese Practice.

At certain plants the practice of preferential oxidation and elimination of carbon and phosphorus has been developed by means of which the residual manganese is kept at a comparatively high value—about 0.25 to 0.30 per cent, as compared to 0.10 per cent manganese, for a final carbon content of 0.10 per cent. This is accomplished, broadly speaking, by rapidly removing the phosphorus and retaining it as stable calcium phosphate during the earlier and colder period of melting, by maintaining a high fishing temperature and working the charge with a high manganese content so that the slag contains about 8 per cent manganese, and by increasing the lime content of the slag to about 47 per cent as a minimum.

This practice possesses undoubted advantages but they are probably best appreciated by those who have developed the practice and have it in operation on a sound commercial basis. First of all, correctly applied, it leads to the production of high grade and uniform steel, which means increased rolling-mill practice, fewer rejections, and a more ready market. This is largely due to the fact that the steel is made where it should be made, in the furnace. A second advantage is derived from the high MnO and CaO contents of the slag; manganese finals can be added to the furnace with a recovery that compares favorably with that of ladle additions. A third advantage is that the same pig iron used for the charge, which contains appreciably more manganese than ordinary basic iron, can be used to recarburize and partly deoxidize the bath; the remainder of the manganese is added as ferromanganese. At a steel plant that operates in conjunction with a blast furnace plant, a harmonious and economical cycle of plant operations is made possible. At the same time the open hearth slag can be resmelted in the blast furnace for the recovery of the iron and manganese and the utilization of the lime.

This practice is largely dependent on the amount of phosphorus in the slag, for it would not be worth while to recover the manganese at the expense of unduly increasing the phosphorus content of the pig iron. In this country we are fortunate in having a large amount of quite low-phosphorus ore available. No definite figure can be given as to the maximum allowable phosphorus content of the pig iron, but it is the opinion of at least one steel man who followed this practice, that 0.6 per cent phosphorus would not be prohibitive.

Under the conditions that prevailed during the past year, this practice possessed the additional advantages that high-manganese pig iron could be secured by smelting domestic manganiferous iron ore and that the manganese alloy added to the furnace at the end of the heat could as well be spiegel as ferromanganese, assuming that the finished steel contains

above about 0.10 per cent carbon. This would not be without its disadvantages, one in particular being that the carbon content of the bath would have to be worked to a lower figure than in present practice. On account of the high cost of spiegel and the greater time required, it is doubtful whether the steel plants will substitute spiegel for ferromanganese. Another point in connection with the possibility of utilizing domestic manganiferous iron ore is that low silica ore can be added to the slag as a source of manganese oxide.

The high manganese content of the charge is generally secured by using a high-manganese pig iron that is 2 or 3 per cent of manganese; but it may also be secured by adding manganese ore to the slag or manganese alloys to the bath or by a combination of these methods. This point would be determined by plant economy but it seems doubtful whether the practice would be worth while unless a high-manganese pig iron were available.[†] The loss of this manganese, by which is meant its oxidation and transference to the slag, is quite great. This loss may be kept at a minimum by increasing the basicity of the slag in CaO and FeO, which, combined with the MnO which also acts as a base, exert the desired effect on the manganese of the bath. As the working of the charge progresses, its temperature rises until finally, with the high CaO, and particularly MnO, content of the slag, the carbon is eliminated more rapidly than the manganese, with the result that the manganese can be held to about 0.3 per cent at the end of the heat. Present data indicate, unfortunately, that no material decrease in the amount of manganese required and no material increase in the recovery of manganese in the additions may be expected, so that the advantages are derived not from a decreased consumption but from the form in which it can be added. Data for one such heat showed that a total of 3,728 lbs. (1,690 kg.) of manganese were used in one form or other to produce 1,272 lbs. (576 kg.) of manganese in the finished steel; or in other words that 2.93 lbs. (1.32 kg.) of manganese were used to produce 1 lb. of manganese in the finished steel. The manganese added in the recarburizer and ferromanganese amounted to 1,068 lbs. (484 kg.) of which, assuming the manganese loss to come from these two sources, 838 lbs. (380 kg.) were recovered in the finished steel, a recovery of 78.4 per cent. In this heat the ferromanganese was added to the furnace. Another heat selected at random, but more representative of standard practice, used 2,190 lbs. (993 kg.) of manganese to produce 1,200 lbs. (544 kg.) of manganese in the finished steel, or 1.82 lbs. (0.8 kg.) of manganese (as

compared to 3.54 lbs.) to produce 1 lb. of manganese in the finished steel.

Open-Hearth Investigations.

Open hearth investigations, in which standard practice will be compared to molten-spiegel practice and high residual manganese practice, will be described later after more complete analytic results have been received.

Use of Manganese-Silicon Alloys.

The high silica content of most of our domestic manganese and manganiferous iron ores made it advisable to consider the possible use of manganese-silicon alloys in steel making, in both acid and basic practice. For the purposes of the present discussion, these alloys will be divided roughly into two classes, high grade silico-manganese containing about 50 per cent manganese and 25 per cent silicon, and low-grade silico-spiegel with about 15 to 20 per cent silicon and 30 to 35 per cent manganese with 50 per cent iron. The manganese-silicon ratio of the first alloy is about 2 and of the second alloy varies from 2 1/3 to 1 1/2. Both of these alloys contain very little carbon. The high grade alloys would be made from the siliceous manganese ores of California and Montana, and the low grade alloys from the siliceous manganiferous iron ores of Minnesota.

While there is nothing new about the practice of using manganese-silicon alloys in steel making[‡] it may be well to review some of the points connected therewith in the light of present requirements. Silicon is always an efficient reducing or settling up agent when in the customary small amount, but it may or may not be desirable in the finished steel. On this account the possibility of using manganese-silicon alloys depends on the amount of silicon that can be tolerated in the finished steel in the ingot form. In certain grades of steel, particularly in steel that must be welded, silicon should be low or practically absent. In steel for sheets and plates, which must give a good finished surface, most efficient rolling-mill practice requires that the silicon be kept tolerably low, but it is believed that from 0.10 to 0.15 per cent could be used provided the manganese were not too high. In forging steel, high-carbon steels, and castings, where the aim is to produce sound steel, more silicon can be used, or between 0.20 and 0.35 per cent. Of these three fields, the last is the one where manganese-silicon alloys will find their first application. In the second field, it seems quite probable that conditions (to be discussed later) will many times permit their use; but from the very nature of things manganese-silicon alloys cannot be used to make steels of the first group.

[†]The writer is informed by one blast furnace superintendent that running the manganese up to 2 per cent does not materially affect the production, so that lowering of pig iron production would not be held as a disadvantage in this practice.

[‡]It is understood that "silico-manganese" has been used fairly extensively in Europe, and in this country it was used at certain plants as standard practice until the supply was cut off by the war.

Manganese-Silicon Alloys in Acid Practice.

It is with considerable difference and hesitation that the discussion of manganese-silicon alloys in open-hearth practice is approached, particularly as the controversial character of many of the points is so clearly recognized. So it may be well, at the outset, to state briefly the manner in which the writer became interested in the possibilities of their use. A number of years ago, he was conducting a series of experiments on the occurrence and identification of foreign inclusions in acid open-hearth steel, principally ordnance steel. In this work ferromanganese, ferrosilicon, and a mixture of ferromanganese and ferrosilicon were added to a steel sample taken shortly after "oreing," that is to "wild" steel, in an attempt to produce an excess of the constituent, or constituents, that were supposed to form as a result of the addition. It seemed fairly clear as a result of this work that the use of silicon was apt to be dangerous, not on account of any harmful effect of the residual metallic silicon but because it produced a constituent (assumed to be SiO_2 , or at least a highly refractory silicate) that was very likely to remain in the ingot and produce hot shortness. This suggested the idea that a manganese-silicon alloy might, and probably would, form a manganese silicate containing some ferrous oxide (a true slag) that would be fluid and more readily coalesce into larger particles than SiO_2 , and, therefore, would free itself more readily from the steel. By using such an alloy, it would be possible to take full advantage of the use of silicon as a deoxidizer without suffering its usual attendant disadvantages. None of the manganese-silicon alloy was available at the time, so a parallel experiment could not be conducted.

Aside from the possibility of securing a better separation of the insoluble products of the deoxidation process, it was assumed as likely, from the fact that binary alloys are known to be generally more active, or powerful, than the weighted sum of the two constituents would indicate, that the alloy of manganese and silicon would prove to be a more powerful reducing agent than ferromanganese and ferrosilicon used separately. On reflection the thought occurs that manganese and silicon, reacting separately with FeO , would produce the oxides MnO or SiO_2 , which may or may not form a solution of MnO and FeO or a silicate of iron. Manganese and silicon reacting as an alloy with FeO would produce a silicate of manganese, which may or may not form a double silicate with FeO . In either case we would expect to find the advantage in favor of the manganese-silicon alloy. The relative weight of the silico-manganese and the ferromanganese plus ferrosilicon mixture will be considered elsewhere.

Another point of great technical importance is the percentage recovery of manganese when added as

silico-manganese and as ferromanganese along with ferrosilicon. First of all let it be stated that a 100 per cent recovery, based on the present theory of deoxidation, is hardly possible; and if possible would not be desirable. It would mean a retention of the products of the deoxidation, to be determined later as metallic manganese and silicon. A method of addition that would lead to a satisfactory deoxidation and yet would eliminate the loss due to admixture with the slag, volatilization, etc., and could be accomplished with the minimum amount of manganese, would be very desirable because it would lead to both conservation of manganese and uniformity of composition of the steel. The first of these points would be given by the actual value of the percentage recovery of the manganese and the second by the constancy of the percentage recovery.

Fortunately, the writer was able to examine records of heats made with silico-manganese covering a period of several years, from which some fairly satisfactory conclusions may be drawn bearing on these points. During this time when silico-manganese was being used there were periods when the alloy was not available and the ferromanganese plus ferrosilicon mixture had to be substituted. This afforded a direct comparison of these two methods of deoxidation. Certain results taken from the heat records, and which are believed to be typical,* are given in the following table. Approximately, the silico-manganese contained

Silico-Manganese vs. Ferromanganese + Ferrosilicon.

Heat.	FeSi, Pounds	FeMn, Pounds	SiMn, Pounds	Total Charge, Pounds	C, Per Cent	Mn, Per Cent	Si, Per Cent	Mn Added, Pounds	Mn Recovered, Pounds	Per Cent, Recovery
A	160	300	...	31,160	0.26	0.56	0.294	240	174	72.5
B	215	400	...	40,765	0.21	0.57	0.306	320	232	72.5
C	160	300	...	30,620	0.32	0.63	0.312	248	193	77.8
D	160	300	...	30,910	0.27	0.70	0.318	240	216	90.0
E	215	400	...	40,865	0.24	0.72	0.312	320	294	91.8
F	...	40	470	41,010	0.22	0.58	0.308	281	238	84.7
G	...	35	350	30,685	0.26	0.60	0.302	214	184	86.0
H	...	40	470	40,960	0.21	0.64	0.310	281	261	93.0
I	...	40	470	40,510	0.21	0.66	0.308	281	267	95.0
J	...	40	420	36,760	0.24	0.68	0.310	255	250	98.0

53 per cent manganese and 20 per cent silicon; the ferromanganese, 80 per cent manganese; and the ferrosilicon, 50 per cent silicon. The residual manganese was neglected in calculating recoveries.

It can hardly be claimed for these figures, or for the three years' records they represent with reasonable accuracy, that they furnish a truly scientific basis of comparison of the two alternate practices, but they do show that the same results (manganese and silicon

* It is obvious that the variation in heat composition and average manganese recovery of several years' practice cannot be given by this table. The records show greater uniformity for the silico-manganese heats.

contents of the finished steel), by using silico-manganese, can be obtained with consistently smaller amounts of both manganese and silicon, as compared to the combination of ferromanganese and ferrosilicon. In addition there is the advantage of having a more uniform practice, which in itself would warrant smaller additions. The weights of the additions favor the silico-manganese; thus in heats A, C, and D, 460 lbs. (208 kg.) were added as compared to 385 lbs. (174 kg.) for G, and in B and E, 615 lbs. (278 kg.) were added as compared to 510 lbs. (231 kg.) in F, H and I. The low carbon content of the silico-manganese may or may not be a material advantage but it is in favor of the single alloy addition because the carbon need not be worked as low and there seems to be less danger of missing the carbon.

Manganese-Silicon Alloys in Electric Furnace Practice.

No information is available, to the writer, bearing on the use of these alloys in electric-furnace practice, but we may at least consider such a possibility on the basis of their known behavior. Considering acid casting practice first, there seems to be no reasonable doubt but that either silico-manganese or silico-spiegel could be at once substituted for ferromanganese and ferrosilicon. Inasmuch as the usual aim is to make high grade castings, the manganese-silicon alloys would appear to have the distinct advantage of making sounder and cleaner steel. Silico-spiegel, aside from possessing the theoretical advantage of being diluted with iron,* could be more readily prepared with the correct manganese-silicon ratio so as to eliminate the use of an additional alloy. The uncertainty of our knowledge as to the relative behavior of the manganese-silicon alloys as compared to the ferroalloys, and the relative efficiency of low-grade and high-grade alloys, as well as the importance of this step in the manufacture of steel, suggest the advisability of conducting a definite research to settle the points. It would seem that there is no better place for such a research than in this particular industry.

In basic electric-furnace practice the manganese-silicon alloys, on the same grounds, could likewise be utilized, particularly as the attempt is always to produce sound and clean ingots. However, in this practice, ferrosilicon is used as a reducing agent along with coke and hence the operator would probably not see any advantage in changing his practice in favor of the manganese-silicon alloys.

Manganese-Silicon Alloys in Basic Open Hearth Practice.

The amount of information available on the use of silico-manganese in basic open hearth practice is

* In this practice the advantage of greater dilution need not carry with it the disadvantage of increased weight on account of the higher temperature of the electric furnace.

very meager, but it can be said that silico-manganese would probably be as satisfactory as ferromanganese and ferrosilicon. Through the cooperation of one steel plant, we were able to follow two shell-steel heats made with silico-manganese, which was added to the ladle. The second of these heats is given here to show what was done. To 11,100 lbs. (5034 kg.) of molten pig iron in the ladle were tapped 122,340 lbs. (estimated) (55,492 kg.) of steel analyzing C 0.09, P 0.012, Mn 0.15, S 0.033, Si 0.02. At the same time 1000 lbs. (453 kg.) of silico-manganese (50 per cent manganese), 300 lbs. (136 kg.) of 70 per cent ferromanganese, 12 lbs. (5 kg.) of aluminum, and 50 lbs. (22 kg.) of coal were added to the ladle. The heat was in excellent condition and the ingots had smooth even tops and displayed no superficial action or evolution of gas. The final analysis was C 0.44, P 0.028, Mn 0.58, S 0.041, and Si 0.21. The recovery of manganese, assuming the entire loss to come from the alloy added, was 77.5 per cent; the recovery of silicon was 65.1 per cent. Only 24 lbs. (10 kg.) of carbon, or 5 per cent of the total, was lost. In the first heat, which was thought to be more highly oxidized, the recovery of silicon was only 58 per cent, while the recovery of manganese was only slightly less. This indicates that silicon protects manganese in oxidized heats.

It was our intention to follow two more heats made by catching the carbon coming down and by adding the silico-manganese to the furnace just before tapping, but this has not as yet been done.

Functions of Manganese.

During such a critical period as that which has now passed, the question might be raised as to the possibility of eliminating manganese from steel making. This point was considered but it was at once held that the use of manganese is not merely an expedient, one for which some substitute might readily be made, but one of the basic requirements of successful, present-day steel works' practice. It is quite true that in many cases the actual amount of manganese used in a heat of steel is greater than the purely metallurgical considerations would call for any excess that might be used may well be considered as so much wasted.

The first function of manganese, broadly considered, is to refine and "settle up" the molten bath of steel. The aim is to put the metal in a proper condition for pouring and to produce ingots (or castings) of the desired quality and texture. While manganese is not the most efficient element that can be used for this purpose, calculated from the heat of combustion of the element to its oxide, it is the most satisfactory on account of the excellent condition (freedom from objectionable foreign inclusions) in which it leaves the bath. The theoretical amount of manganese required might possibly be calculated from the amount of oxygen converted from the active form FeO to the inactive form MnO.

Reliable Performance of Large Turbines

Commercial Practicability of Large Units Demonstrated by Installations in Successful Operation—Reliability and Operation Placed First, Efficiency Second and Cost Third.

Significant in the development of the electric power industry is the concentration of generating capacity.

This is favored, first, by growth of industrial load, which centers about the cities, and second by the economic advantages of the large central station over the smaller one. At the present time there are six districts in the United States in which the maximum sustained peak load on all companies is above 150,000 kw, and one of these has a peak of 800,000 kw. These large and growing loads have put it up to the manufacturers to design generating units with regard to their full-load characteristics, and without limitations of size. With the rapid increase of size there has been a feeling in some quarters that the limits of good practice have been exceeded, and that safety and reliability had been sacrificed for economy.

That such is not the case, has been shown in a paper recently presented before the American Society of Mechanical Engineers by J. F. Johnson, engineer of the turbine department of the Westinghouse Electric & Manufacturing Co. Ten machines of this company's manufacture, from 30,000 to 70,000 kw., capacity, are now in service and have been in use for periods of from one to five years. Their performance removes any doubt of the commercial practicability of such large units.

Three machines, of identical design, were installed in the East Seventy-fourth street power house of the Interborough Rapid Transit Company, in the years 1914-1915. They are rated at 30,000 kw each and are of the two-cylinder cross-

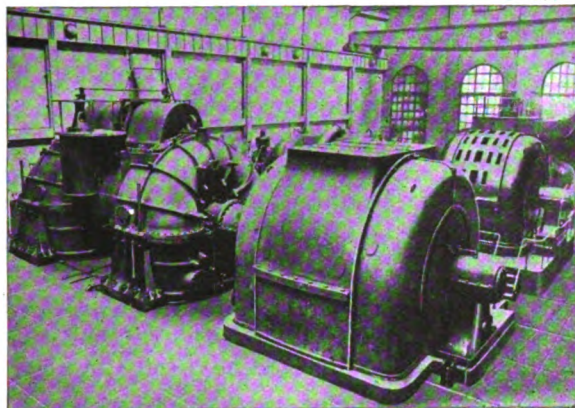
compound pure reaction type, the high pressure operating at 1,500 rpm, with steam at 205 pounds and 120-degree superheat, and the low pressure at 750 rpm, exhausting into a 29 inch vacuum. Two units have had no trouble of any sort and have been out of service only for periodical inspection and maintenance. On the remaining machine the labyrinth packing on the balance pistons of the high pressure element has failed three times, requiring renewals of some parts. Investigation finally showed excessive lost motion in the thrust bearing and heavy distorting stresses, due to rigid bracing of the steam pipe near the turbine.

Another 30,000 kw unit, installed in the Northwest station of the Commonwealth Edison Company, of Chicago, in September, 1917,

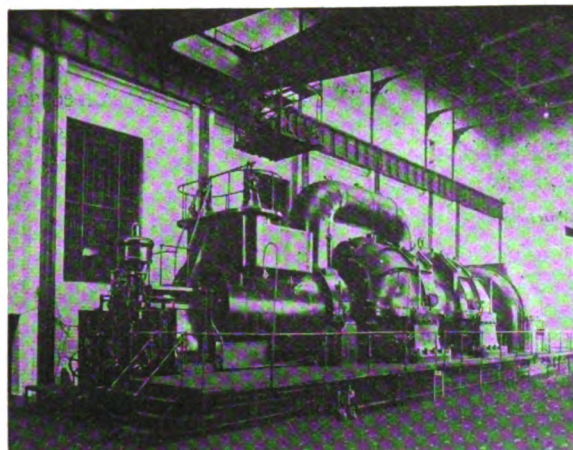
consists of tandem compound, pure reaction type of turbine operating at 1,200 rpm with 220 pounds steam pressure, 200 degrees superheat, and 29 inch vacuum. A few hours after being put into service, the labyrinth peaking on the low-pressure element failed, due to rigid piping between the two surface condensers, which prevented them from moving with the turbine casing (to which they are bolted). Temporary local repairs were made and the unit put into service and no further trouble, save a cracked expansion joint, has developed, and on one run the unit was in service for 71 days, being taken off the line only to clean the condensers.

Two duplicate machines, of 30,000 kw each, single cylinder, pure reaction type, 200 pounds steam pressure, 100 degrees

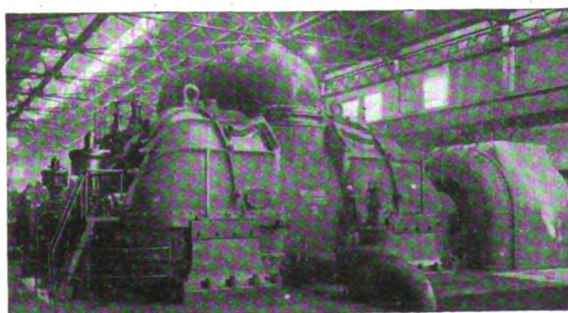
superheat, 29 inch vacuum, were placed in Brooklyn late in 1917. One is in the Gold street station of the



35,000 kw turbine generator, installed in the Commonwealth Edison Company, Chicago, Ill.



30,000 kw turbine generator, installed in the Brooklyn Edison Company, Brooklyn, N. Y.



40,000 kw turbine generator, installed in the Duquesne Light Company, Pittsburgh, Pa.

superheat, 29 inch vacuum, were placed in Brooklyn late in 1917. One is in the Gold street station of the

Edison company, and owing to urgency, was not operated at the manufacturer's works. After installation no correction of balance was necessary. The only troubles were a few leaks in the oiling system, and a defective gear in the oil-pump drive. This unit has been in operation continuously except Sundays, and when necessary to clean condensers, at average loads of 23,000 kw and peaks as high as 32,000 kw.

The companion machine was installed in the Kent avenue station of Brooklyn Rapid Transit Company, about the same time. Just after installation, some re-balancing of turbine and generator rotors was necessary, and after 10 months' service the thrust bearing overheated and wiped somewhat, but did no other damage. On inspection, the labyrinth packing strips, of aluminum alloy, were found corroded by the action of strong alkalis used for treating feed water, and two rows of high pressure blading were found damaged at some previous time, caused by foreign matter or a defective blade. At another inspection 10 months later, a few rows of blading were found damaged, and some new gland parts were required.

A 40,000 kw. cross-compound machine has been in service at the Brunot's Island station of the Duquesne Light Company since December, 1917. The high-pressure element operates at 1,800 rpm, and the low-pressure element at 1,200 rpm. This unit has been in carrying loads of 30,000 to 40,000 kw, with peaks as high as 50,000 kw. In February the main bearing at the coupling end of the high-pressure turbine burned out, apparently due to interruption of its oil supply. This let the spindle down sufficiently to cause rather heavy blade rubs throughout the machine. After rebabbiting the bearing, the machine was put back into service, the only other work being rechecking clearances and placing a balance weight on the spindle to correct for weight rubbed off the blades. In July the generator was damaged by electrical trouble, and while this was being repaired, both elements of the turbine were dismantled, and a small amount of damaged blading was replaced.

Another unit, practically a duplicate of the preceding one, but rated at 45,000 kw was placed in service in the Providence plant of the Narragansett Electric Light Company, in January, 1918. Due to improper initial adjustment the labyrinth packing on the high-pressure element was damaged, requiring temporary repairs. Later, the couplings were distorted slightly by a series of violent short circuits, together with defective workmanship in fitting the coupling keys. Permanent repairs to the packing have been completed, but the old couplings are still operating satisfactorily without signs of distress. Loads on this machine run as low as 5,000 kw, and on peaks it carries 50,000 kw for five minutes.

The largest unit of all is a 70,000 kw three-cylinder machine, installed in the East Seventy-fourth street station of the Interborough Rapid Transit Company, in New York. One low-pressure element was cut in on

April 18, 1918, on high-pressure steam. The high-pressure element was put in service August 21, and the second on October 9. On the first low-pressure element, lack of sufficient clearance on one spindle ring caused distortion and some intermittent vibration. Later a few defective blades on the second low-pressure machine were replaced. The automatic devices for cutting out a defective element without disturbing the other two have been tried out with great success. This machine has carried loads of 55,000 kw with savings up to 61,000 kw.

While these records do not show 100 per cent in all respects, they do show that in no instance has there been any evidence of basic defects in design, or inherent difficulties in operation. Troubles have all been of minor character, due to avoidable defects in details, such as are found in new apparatus of any sort or size. It is significant that with the exception of the Duquesne Light unit, no important part has been returned to the manufacturer for repair or alteration. While most of the installations have not been formally tested for steam consumption, yet definite reductions in station coal consumption have been effected by their use.

The satisfactory performance of these units has been due to the designers' insistence that reliability and general operative excellence should come first, efficiency second, and cost third. The great range of steam temperature and pressure from throttle to condenser makes it necessary to harmonize these three elements, and hence there is a constant temptation to cut the initial cost at the expense of reliability. For instance, a single-cylinder machine is cheaper than a two-cylinder machine, but the high-speed and large dimensions of the low-pressure blading in a single-cylinder machine introduce large stresses and vibration. Theoretically, these stresses may be offset by using specially strong materials, but these require sensitive heat treatment, and do not have the uniformity of the commercially common materials. What is really wanted is a generating unit which will carry the load day in and day out with good economy, letting the interest on increased cost be taken care of by the savings in repair and operating charges. It is well known that the larger turbines show a saving in building cost, in radiation and pressure losses in the piping, and in attendance, to say nothing of their somewhat higher efficiency. When conservatively designed, their operating reliability has proved to be all that could be desired by the most cautious engineer, and any public service company need have no hesitation in staking its reputation for continuous service on their reliability.

EDITOR'S NOTE—This article points out very satisfactorily, that the contention that large turbines have been designed beyond the point of safety and reliability, is unfounded. As is pointed defects liable in any new installation have arisen, but those have been remedied to the satisfaction of the user. It is to be hoped that more data and information of the character brought out in this article will find its way into the technical press.

International Influence on Steel Industry

American Production Will Influence and Be Influenced by Steel Industries of Foreign Countries to a Greater Extent Than Heretofore—International Understanding of Problems Important.

By L. W. ALWYN SCHMIDT.

With the world dependent for approximately 50 per cent of its present and future production of iron and steel upon the United States, it is clear that the American steel industry will exert a considerable influence on the iron and steel markets of the world. But such an influence cannot be exerted without that also counter influences originating in other countries will take effect on conditions in our own industry. True, the United States exports of pig iron and manufactured steel are small in comparison to the total production, but they have increased rapidly. Much iron and steel produced in this country also goes into building material and industrial equipment of which a great deal is exported. An increase in the demand for industrial equipment in Europe, necessitating a larger consumption of European pig iron and steel must create therefore, immediately, an increase in the demand for American iron and steel from countries which otherwise would have covered their requirements from European sources. An overproduction of manufactured iron and steel for which no sale can be had in Europe in turn may decrease our own business with the rest of the world or even force down prices in our own market. A drop in steel prices in this country will reflect instantly on steel prices in Europe.

Conditions over which we have no control are affecting constantly the wellbeing of our iron industry. Many of these conditions are incidental to the steel and iron industry, others have their causes outside the iron and steel field proper. They are of a general character affecting steel and iron as much as any other commodity of international commerce. Such conditions may exist in all branches of those international activities which in their totality make that intricate machinery called international trade. They are found and react most strongly in the different fields of transportation, especially in ocean shipping, in international exchange, general industrial activity, railroad development, price constellation, labor and even in the more national sphere of legislation, as taxation, etc.

Although we have got accustomed to use colloquially such expressions as "that one country manufactures more expensively or cheaper than the other," there remains nevertheless the fact that as regards the so-called leading commodities no country has a marked advantage with reference to the price at which these commodities can finally be sold in the world's market. The cost of labor may be higher in the United States

as compared with Europe or transportation may cost more. The handicap as a rule is wiped off the slate somewhere between the point where the ore goes to the furnaces and where it reaches the ultimate consumer, and the latter pays approximately the same price for American iron as he will have to pay for the European product of the same quality. The difference is adjusted by more efficient methods of production, by less costly distribution or by a more flexible system of charging profits.

Whatever methods are applied to keep the product competitive in the world's market, the result will be always the same. But to obtain this result the brainwork of many men is required who all are kept busy from morning to night by this permanent job of readjusting cost and prices for the purpose of neutralizing the effect of the factors, inherent or foreign, operating to the benefit or disadvantage of our national iron and steel industry.

The great nations of the world, with the exception of England, have tried to eliminate the effect of these outside influences on their own industries by the erection of tariff walls. But while in this way the national production and distribution has been freed at least in part from the effect of international economic actions these influences continue to operate with unremitted strength on all those activities, carrying the industry across the frontiers of the own country.

So far little attention has been given in this country to the study of international influences acting on our own industries. With the growth of our export trade and the expansion of our financial interests in other countries we cannot afford, however, any more to lead the life of the recluse. Economic thought and speculation in this country will have to take into consideration the position of our own industry as part of a great system of industries covering all the world. We shall have to learn that our iron and steel industry cannot remain indifferent to the opening of new shipping ways, to the up and down of international exchanges, or to labor conditions in other countries. We must acquire the habit of seeing these expressions of economic activity around us and to apply them to our own conditions, especially to the study of how they may change our own relations to the remaining world.

The last four years have been full of great changes. Many are of so fundamental a character that they may

ultimately revolutionize the international relations of our leading industries, the iron and steel industry included. A beginning may be made with ocean transportation.

There has been of lately a good deal of general talk in the press about the new situation created by the growth of our national merchant marine. Much has been said about its enormous carrying capacity, about the difficulty of operating it, its operating cost, etc. Nobody so far, however, has pointed to the enormous advantage our industries are bound to derive from the fact that this fleet of merchant ships, being the property of the United States, now can be routed in such a way as to serve actually the distribution of American industrial and other products. The American steel industry is vitally interested in this question. Shipping has a natural inclination to congregate at points where freight may be obtained. But the attraction of the home port always remains and the ships of a nation, wherever they are, will serve principally their own country and only take foreign freight if none can be had to the home port. The principal difficulty experienced by the American iron and steel industry in prewar times resulting from the lack of American shipping has been the lack of shipping for transporting iron from this country to ports outside the big routes of international commerce. The big seafaring nations had very little interest to carry our iron and steel to countries but their own, as they preferred to sell their own steel. Theoretically there has not been a discrimination in rates against this country. In practice, however, differences have existed nevertheless and have had a very material influence on the sale and price of American iron and steel. Much of the iron and steel shipped from one country to another is carried in normal times in so-called tramp steamers. These, in taking shipments, do not follow the rates established by the regular lines, but accept freight according to daily rates governed by the demand for shipping. When better paying freights could be obtained in the direction of Europe, these ships would give preference to the European trip. In fact, shipping moved in the European interest, and there was little sentiment lost between the foreign carriers and our own exporters.

The truth of this has been fully realized by our big iron and steel producers, and nearly all have owned their own ocean carriers already before the war. But only the smallest part of the exports of iron and steel of this country is shipped in half-manufactured state, in bars, pigs, ingots, etc. Much more leaves this country in a more advanced stage of manufacture. A big steel company may be able to dispose of shiploads of its product. The machinery manufacturer can send only one machine or a few to one market, and it is that trade which has been discriminated against, possibly unwillingly, by the foreign shippers.

The existence of an American merchant marine will do away with this disadvantage. How important careful routing often may be to the development of an international trade in primary commodities, has been shown already in prewar times. Sweden, for instance, had prepared for the opening of the Panama Canal by ordering a number of ore carriers which were to use the canal for bringing Chilean ore to Swedish furnaces. Germany made a very effective use of her slow shipping going from Germany to the South American west coast for the purpose of bringing nitrate to Germany by loading these ships with heavy and not well paying commodities, including iron and steel. Our iron and steel industry will have to keep a watch in future on these developments and to inquire into their likely effect on the development of our own foreign business.

The foreign business of an industry, the production of which is so extremely sensitive to foreign influence as that of the iron and steel industry, depends for its success in foreign markets not only on the existence of well conducted means of distribution but also on favorable financial conditions. If a certain quantity of iron delivered in Argentine commands a certain price independently whether it is supplied by the United States or any other country, that country will receive the order which offers to the purchaser in Argentine the most favorable exchange conditions. It is an old financial rule that a high exchange in favor of one country will drive the purchases of the "adverse" market to other countries but that a low exchange rate encourages trade. This is an economic maxim which cannot be understood too clearly in this country especially under present day conditions. The abnormal state of the world's finances caused by the war have made it extremely difficult for the financiers of all countries to keep at par the money exchanges between the principal markets of the world. The United States, by lending vast amounts and shipping enormous quantities of commodities against both of which no corresponding values could be delivered, have gained an increasing influence on international finance, which if left unchecked may prove actually a serious obstacle to our foreign trade. The effect of this situation on steel exports can be easily explained. Take the position of a manufacturer of machine tools in France who has to buy steel. Let him order a quantity of steel in this country costing \$100,000. In normal times he would have to pay 500,000 francs in French money. If the purchase had been made during the time when six francs were the international equivalent (the exchange value) of the franc for the dollar, his purchase would have cost 600,000 francs. During the same time the American manufacturer of machine tools still has paid \$100,000. If both were to make machine tools from the steel which they bought, the American maker would be able to sell his machine tools for \$200,000 approximately, allowing \$100,000 to

pay for manufacture, labor and his profit. The French manufacturer trying to sell at the same price having paid 100,000 francs more for the steel, owing to the higher exchange, immediately would be in the disadvantage against his American competitor at the rate of \$20,000. What is the result? The French manufacturer will buy his steel either in his own country or from a market where the franc has a better standing in exchange than is the case in the United States.

The application to present day conditions is obvious. Germany is expected to pay a very heavy indemnity to the allied countries. The process of paying would create a financial vacuum in Germany of such strength as to attract to it the commerce of the whole world to the disadvantage of all other industrial nations. Hence the difficulty of settling the vexing question of the German indemnity without injuring at the same time the nation receiving it.

These few examples will have shown already the importance of maintaining a normal foreign exchange for the future business of our own iron and steel industry. The foreign business of the American iron and steel industry has moved very irregularly during the war. Our foreign customers were too anxious to get supplies as to worry very much about unfavorable or favorable exchange. The exchange situation, however, will play a very important part in after-war trade, and a few cents increase on the dollar in the purchase price owing to an unfavorable exchange may turn the scale of a large order in favor of another country.

Every problem, be it of distribution or exchange, finally centers around the one and principal question of price. A drop in the price of European steel may knock the bottom out of the American steel industry, it will make unsaleable its products in all the markets of the world. It may, in fact, lay open our industry to an attack in its own home market. It has been explained already that it is hardly conceivable that a very heavy difference in the price of steel might occur under present-day economic conditions. But there are variations to the theme which may well be noted as they will be of considerable influence on international steel distribution. Every commodity has a competitive distribution radius, the extent of which depends largely on special local conditions. English iron, for instance, sells over a large part of Europe and remains competitive with continental iron. In the summer when the rivers are open, English steel and iron penetrates much deeper in the European continent than during the winter when only railroad transportation can be used. In each case the cost of transportation added to the cost of production is the deciding factor. If the cost of production increases, the shipment will stand less distribution expense only, and the point of loss of competitive ability will be reached much earlier.

The increase in the cost of steel production in Europe expected as a result of the war, therefore, will be of considerable influence on the distribution of European steel not only in Europe but also in other parts of the world.

Changes in the labor situation of a buying country may have a much more decided influence on the production of steel and iron in our own country than only a change of price, as it may alter completely the character of the demand. We have had examples of what a change in the cost of labor can do to an industry in our own country. We may now see something similar in Europe. The present wages demanded by the German iron workers as a result of the revolution, of course, will not hold good and will be reduced again after normal conditions have been established. But it must be clear to every thinking man that Germany, if it should be compelled to raise wages above its present level, cannot continue to sell at its present prewar prices. It, therefore, must either reduce its output, or it must turn to other methods of production. One solution would be the application of American methods. The other would be to discontinue the manufacture of cheap goods entirely and concentrate on high class products as automatic machinery, precision machinery, etc. In both cases the effect would be felt in the iron industry of the world. Germany either might have more iron available for export than is expected just now, or a German demand for high class steel would arise. Two million tons of pig iron or steel exported by Germany means a corresponding reduction in the sales of the other countries. A larger demand for high class steel from the same source would lead probably to an increase in the cost of the latter. Similarly, France, in the possession of Alsace-Lorraine and cheap labor, may turn the scale in steel production unfavorable against our own industry. Extensive strikes in one country must increase the demand for steel in another.

Very much as a change in the industrial character of a nation will affect the character of the demand for steel coming from that quarter, so the growth of its industry will add to the world's consumption of steel. We have had a very good example of the correctness of this contention in the rapidly increasing consumption of iron and steel in such countries as Norway and Sweden, and, to give another example, in Brazil and Argentine. In all these countries, new industries have grown up as the result of the war, and a corresponding demand for iron and steel has followed. Of all the international influences affecting the business of the iron and steel industry this natural expansion of the demand following industrial growth is the most forceful. It is the driving factor of international commerce. Its effects on the foreign trade of the iron and steel industry are continually noticeable in changes in the direction of the exports of iron and steel.

Furnace Company Completes New Plant

Modern Electric Furnace Manufacturing Plant Built by the Electric Furnace Company—Completed at Salem, O.—New Plant Result of Development in Business—Illustrations and Description.

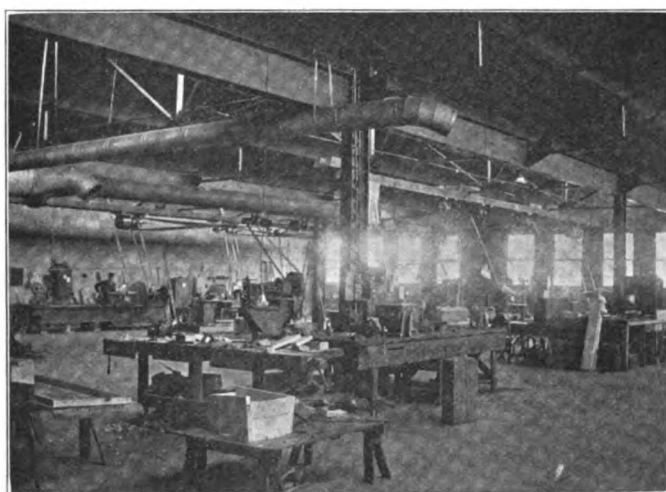
Peace has come abruptly, and American industry is again thrown completely upon its own resources. Problems are developing that call for better production methods than those which have long been considered standard. A tangible proof of an industrial demand for more modern methods, is found in the large plant just occupied by the Electric Furnace Company, at Salem, O. This factory is used exclusively for the manufacture of Baily furnaces for the electrical heat-treating and annealing of steel and melting of non-ferrous metals.

The ever-widening field of work to which electricity may be applied, has attracted the greatest interest throughout industry. Every month we read of new electrical inventions that accomplish tasks, generally considered impossible. We have long been

100 feet facing Wilson street. Adjoining the main building are two sawtooth roofed buildings, one 201x97, and the other 97x54.

As you enter the general office building, the view on the left reveals commodious offices; the right wing, however, is devoted to a large record room. Here all specifications and drawings of the particular needs of furnace customers, are carefully preserved.

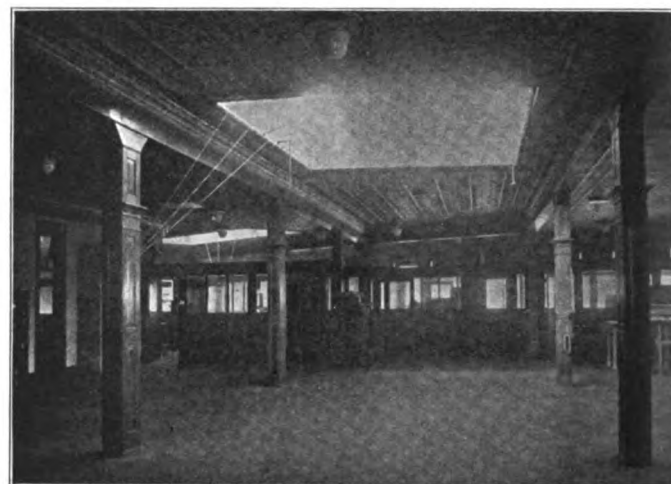
Adjoining this office wing is a large, well-lighted drafting room. While this room is unusually large in size, it is no more than adequate because electric furnaces, especially large automatic types, require the highest mechanical skill in design, and this floor furnishes a pleasant and ideal location for securing the infinite detail of the drafting room. A blue print room in the rear is provided with usual equipment.



View showing machine shop.

familiar with the common use of electricity, but modern research now demonstrates that heating problems also may be solved by drawing furnace current from the same central station that drives the motors in the factory. A consideration of the Baily factory is worth while, not so much from a standpoint of shop equipment, but from a viewpoint of the unique features that make an electric furnace plant distinct and modern.

The imperative demands of a growing business led to the equipping of the plant shown in the illustration. This two story factory with about 70,000 square feet of floor space is located on a tract of nine acres along the main line of the Pennsylvania railroad at Salem, O. This modern factory has a two-story main building, 96 feet fronting the Pennsylvania, and



Interior view of office.

One other exclusive feature of this room is worthy of attention. A large routing board on the north wall offers a very thorough and modern method of keeping track of production by showing the exact routing of all materials and the progress made on every contract handled.

Special Electric Furnace Laboratory.

In the northwest wing of the factory, a special electric furnace laboratory is maintained, including a modern chemical laboratory for making analyses and conducting tests upon various metal and upon refractories and furnace construction parts as well.

An adjunct to the laboratory is found in a modern electric brass foundry, where two standard 7 ft. 105 kw Baily furnaces are making tests on specific materials, and in addition are producing copper castings

required in the factory. This is of special importance because these copper castings must have a high electrical conductivity which is difficult to obtain in any other furnace practice. A smaller 40 kw furnace is used for small intermittent tests of refractories and alloys. The entire equipment makes possible the most efficient research into chemical and metallurgical fields. The dirt, smoke, fumes, and flame of the pit-crucible plant are entirely absent in this ideal foundry.

Switch and Transformer Construction.

Passing from the foundry, a steel-tank assembly room is found where sheet steel is fluted and oxy-acetylene welded into tanks for transformers. Later these tanks go to a foundry, where steel tops and bottoms are cast on them.

The machine shop, although modern in every respect, deserves only passing mention here. The switch shop, on the other hand, is distinctly interesting, because its expert machinists must perform some of the most delicate operations that electric furnace construction demands. It was very difficult in the early days, to find satisfactory low tension switch equipment until one of the company's engineers designed the present selective oil break switch. These are built with the greatest accuracy and most care-

ful fitting, yet all parts of the switch are interchangeable.

Following the transformers out to the assembly floor, much of electrical interest may be seen. Here transformer coils are loaded on blocks to await the coils that are receiving treatment on the other side of the floor. Coils are here too, ready to be impregnated, and in the rear of the room winding lathes are drawing copper wire from a score of drums. Material must be carried in stock sufficient to provide for the needs of transformers for voltages up to 22,000 and in the whole range of sizes.

Three stock rooms are maintained. In addition to the general and pattern storage rooms, a large space is devoted to brick and refractory storage. A large stock of special brick is necessary to assure prompt furnace shipments.

The last floor is devoted to structural assembly. Here the structural steel shell of the furnace is finally assembled with all its external and internal equipment. A special Pennsylvania siding adjoins the floor that the product may be easily loaded upon cars.

As a whole, the Electric Furnace Company, has a plant that represents clearly the growing use of electricity as a source of heat for just as wide a field of heating operations, as that which it now dominates for light and power.

Practical Pointers on Heating Furnaces

Demand for Better Product and Reduction of Furnace Losses Causes Change in Design to Meet New Conditions—Hearth Areas Increased, Furnaces Made Larger and Walls Thicker.

By GEORGE J. HAGAN.

An interesting and valuable contribution to the technical literature of the industry was presented by George J. Hagan, general manager of the Geo. J. Hagan Company, Pittsburgh, before the Engineers Society of Western Pennsylvania. Mr. Hagan's paper entitled "The Design of Heating Furnaces From a Practical Standpoint," deals with heating furnaces in general for treatment of both light and heavy stock; method of design and construction, and continuous furnaces for wash heat. Concerning the changes in the design of heating furnaces made, due to the increased demand for the product treated in this type of furnace, Mr. Hagan says in part:

"Hearth areas were increased, the furnaces generally made larger, and the walls thickened up. Double instead of single furnaces were adopted, with partition walls permitting of both sides of the furnace being used at the same time. With this construction, one side of the furnace can, without any detrimental effect,

contain a hot charge while the other side is ready to receive a cold one. Furnace temperatures were cut down so as to maintain the proper heat for working the materials. This was accomplished by charging larger tonnage and allowing a greater time for the materials to absorb the requisite amount of heat, while at the same time the temperature of the off-going gases was reduced, effecting further economy. Considerable attention was given to the question of excess air for combustion, with the result of practically eliminating the serious troubles and losses due to scaling. In fact, today, black tinplate of 32 gauge for tinning purposes, high grade sheet that will stand spinning, and deep drawn work—such as 'tea-tray stock'—can be heated with scarcely a trace of scale forming. These latter stocks require surface finish as nearly perfect as possible, and to secure this the heating had to be absolutely uniform and the scale eliminated. Oil as fuel for this purpose was not found satisfactory on account of the pitting that occurred on the surface of the sheets. Natural gas was ideal but the scarcity of

Abstract of paper read before Engineers' Society of Western Pennsylvania.

it, coupled with the uncertainty of the supply and the high cost as compared to coal properly fired, gradually resulted in coal being adopted as the logical fuel; so that today I am safe in saying that I have equipped 85 per cent of all the sheet and tin mills of this country with automatic stokers for coal burning.

"The combination sheet and pair furnace has given excellent results. This type consists of two furnaces in tandem with a combustion chamber or firebox at one end. Next to the firebox is the pair-heating furnace, then the sheet or final heating furnace. Today, in our best working furnaces, the crown runs in a straight line from the stern wall, to the front line of the bridge wall, thence it slopes downward. This slope as a rule is $1\frac{1}{4}$ inches to the foot. The height of the skew-back line at the front wall of the furnace must be three inches greater than the maximum width of the sheet which it is possible to work on the particular mill to which the furnace belongs. The modern furnace is known as a double furnace. For instance, in a furnace designed for a given sized mill, the width of the door to each chamber is six inches wider than the maximum width of the sheet. Each chamber of the sheet-heating furnace must have sufficient room to permit of edging the sheets. The chambers are charged with a pack of iron on the hearth in line with the doors and, as a rule, a space of $13\frac{1}{2}$ to 18 inches is allowed on each side of the pack for edging. The combustion chamber is designed to suit the fuel being used, coal being the most common fuel in practice today. In designing this furnace for coal, if hand firing is employed, the grate area should not be less than 20 per cent of the hearth area. If it is stoker fired, naturally the chamber must be designed to suit the stoker that is applicable for the purpose.

Annealing Light Stock.

"So far there has been no mention made of annealing light stock. Light sheets are stacked close and box annealed; that is, the sheets all come in contact and are piled one upon another on a cast-iron bottom to a height to suit the annealing equipment, often four to five feet. These sheets being light are, of course, all handled by hand. In sheet mill practice the charge runs anywhere from 15 to 25 tons. A cast-steel box is put over the pile of sheets and allowed to rest on the same bottom on which the sheets bear. Sand is used to seal the box at the bottom, and the complete charge with the box and bottom is rolled into the furnace by mechanical means. The type of furnace for annealing this grade of stock formerly used a hollow bottom. These furnaces were only about 7 feet wide and 14 to 15 feet in depth. Natural gas, producer gas, oil, and coal were the fuels used, the coal being hand fired. The first boxes and bottoms

for containing the sheets were of heavy plate riveted construction, but in recent years a demand for longer and wider sheets was made. This demand, naturally, could not be taken care of without changes in the furnace equipments, and today the modern furnace employs very heavy cast steel bottoms and boxes, naturally adding weight and area, while the charge is somewhat heavier on certain orders and the demand for quality is becoming more insistent right along. In annealing the sheets the temperatures should be absolutely uniform all around the box. The standard furnace is a stoker-fired furnace of continuous bridge-wall construction with draft outlets at the low point on the far side of furnace from the bridge-wall. The bottoms and annealing boxes are kept at a certain distance from the hearth so that the flames or gases can pass between the hearth of the furnace and the under side of the boxes. The height of the crown at the bridge-wall side of the furnace is much higher than the crown at the same relative point on the far side of the box. This is essential in order that the hot gases coming over the bridge wall should have greater room for expansion and thus prevent severe action on the flame on the top of the annealing boxes. The gases pass over the top of the box and down along the sides. A slight excess pressure is carried at practically all times thus allowing the furnace to fill completely with flame. The bridge-wall construction permits of increasing or decreasing the height; thus, when a furnace is first put in operation and an adjustment is required for more uniform distribution of heat, it is an easy matter to take care of this. This type of furnace has proven a very marked improvement over former practice where the hollow bottom and other fuels were used. It formerly required 14 to 18 hours to bring a 20-ton charge up to correct annealing temperature, while this particular type of furnace will bring a 25 to 30-ton charge up to annealing temperature from a cold furnace in 10 to 11 hours of actual firing. After the correct temperature has been reached, approximately 1,500 degrees, these boxes are allowed to soak. The soaking period varies somewhat in different plants, but the correct practice is to allow the boxes with their charge to soak from 10 to 15 hours, by which time the sheets and boxes have practically cooled down to a point where the box can be pulled and removed immediately. Of course, to follow out these ideal conditions correctly, a large number of furnaces are required to take care of the tonnage but there are really very few plants which are equipped in this way. Common practice is to bring the charge up to annealing temperature, allow it to soak for five or six hours, and then remove; but allow the box to remain until the charge has cooled down to a temperature at which the box can be removed without danger of scaling the sheets by exposure to cold air. This later course is very severe

on the boxes and if the charge is allowed to cool down too rapidly the annealing is not as good.

"In jobbing and plate mill practice the greater part of the stock is open annealed. This really should not be classed with annealing when compared with the interpretation 'annealing sheet-mill stock.' Open annealing is nothing more than the reheating of plates, which does, to a large extent, remove the stresses in the plate after it has cooled down from its initial heat. These plates, as a rule, are kept on conveyors or casters after they leave the rolls; and are charged almost immediately into an open annealing furnace, the term 'open annealing' implying that the plate is exposed to the direct flame. These plates are charged from the casters to the annealing furnace by hand, which calls for skillful manipulation of the tongs. The old practice, which is still extensively followed, uses a solid-bottom furnace of continuous bridge-wall construction. These furnaces are 8 to 10 feet in width and vary in length, usually being a little over twice as long as the longest plate worked on the mill. This permits two plates to be in the furnace at one time. Sometimes several furnaces of shorter lengths are used for each mill, but usually two furnaces of greater length are required for handling the output of one jobbing mill. The bottoms of the furnaces always have an outside slope from charging door to discharging door, in order that the plates can be more readily charged into the furnace and dragged out from the opposite end.

At the time the new plant of the Otis Steel Company was constructed, a continuous open-annealing furnace was installed. This was very interesting to me as it was something I had looked forward to for a long time. I paid particular attention to the work and after this furnace was put in operation found that the unique principle used gave every sign of being satisfactory. The new departure consisted principally of refractory rollers supported by water-cooled axles. These rollers were of such design that their refractory surfaces were always of the same temperature as that of the heating chamber. The running of water through the shaft was only for the purpose of keeping it cool, and it was insulated so the water would have no cooling effect on the surface of the rolls. No black spots of any kind appeared on the surface of the plates. A pinch roller was provided on the charging end of the furnace, as well as on the exit end, these pinch rollers being operated by power the same as the rollers inside the furnace. The shafts of all rollers extended through the side walls where bearings were provided, and the rolls were driven by chain and sprocket, operated by a variable-speed motor of the reversing type. The use of this furnace eliminated to a large extent the labor required for the old type, and permitted of the furnaces being built much longer than those previously used. The annealing qualities are far superior; there is no labor required for dragging the plates through the furnace, and tonnage can be easily doubled with a very

substantial increase in efficiency. This furnace is known as the Costello open-annealing furnace. Since the first installation at the Otis Steel Company's plant, this furnace has been taken up by the Canton Sheet Steel Company, the Western Reserve Steel Company, the Brier Hill Steel Company, and the Newport Rolling Mill Company. There was no complaint whatever regarding the operation of these furnaces, but it was found that the refractory rollers would not stand up any great length of time. They were subjected to every element that would cause their failure; for instance, abrasion, vibration due to sprocket drive, changes in temperature—and all these in addition to carrying the actual load of the charge. The difficulty experienced was in retaining the brick around the axles. The brick used were side-arch brick beveled on each end and held in place by cast-steel disks which were also beveled. The width of the furnace governed the number of disks and circles of side-arch brick. Expansion and contraction had to be provided for, and this was accomplished by sliding a pipe sleeve over the water-cooled shaft with a spring on the outside of the shaft next to the bearing to take care of the tension, and allow for contraction and expansion. The brick, however, would spall and crack, and as I had considerable to do with the designing of this furnace I spent a lot of time endeavoring to overcome the difficulty. I found it was not really a question of getting the proper refractory material and, to make a long story short, the trouble was finally eliminated by the use of a certain refractory cement. We experimented with every refractory cement that was brought to our attention, and all of these cements were of some benefit, but the one that proved entirely satisfactory appeared to go into working condition much sooner than the others and upon closer investigation we found that this cement really had welded the joints and welded them at a temperature of between 1,000 and 1,200 degrees F. It was found that a chemical of some kind used in this cement caused a slight flux to occur at the above temperatures. The flux was almost instantaneous, and actually made one solid mass of the brickwork, so that the joints were stronger than the brick. Due to the use of this cement there had been no further trouble with the rolls. This type of furnace for this particular class of work is certainly worth the consideration of anyone requiring open annealing of either sheets or plates, as it is far superior to the old-fashioned furnace.

Heating Heavy Stock.

"In designing a furnace for heating heavy ingots for forging and press work, the stock is usually brought to a temperature of 2,000 to 2,100 degrees F. If it is special alloy steel the heating conditions are considerably different from those required for ordinary material. Special alloy stock is charged into a practically cold furnace and brought up to its working temperature very gradually, to prevent, as far as possible, surface cracks. When surface cracks do

(Continued on Page 163)

Investigation of Gases Occluded in Steel

Composition and Volume of Occluded Gases and Their Effect Upon the Physical Properties of the Metal—Relation Between Temperature at Evolution of Gas and Electrical Point.

By THOMAS BAKER.

It is well known that iron and steel are capable of holding in solution or otherwise considerable quantities of gas, and that these are often far from negligible. Many investigators have attacked the problem with the object of ascertaining the composition and volume of these gases and their effect on the physical properties of the metal, but little is known on this subject beyond the part they play in the production of blowholes, and in a peculiar kind of brittleness which is developed by pickling.

Some years ago the author carried out an investigation with the above-mentioned object, and also to discover the relation, if any exists, between the temperature of evolution of the gas and the critical points of the steel.

For this purpose two crucible steel ingots about 6 cm. square were prepared in such a way that while one was free from blowholes the other contained as many as possible. In addition to this material there were also obtained some samples of dead soft steel such as is employed in the manufacture of tin plate. The chemical analysis of these materials are given in Table I.

Table I.

	C.	Sil.	Mn.	S.	P.	Al.	F.
Solid ingot.....	0.90	0.088	0.096	0.023	0.019	0.033	99.01
Ingot with blowholes...	0.81	0.080	0.050	0.028	0.019	—	98.84
Soft steel ingot.....	0.13	0.011	0.370	0.053	0.075	—	99.36

The apparatus employed for the extraction of the gases consisted of a porcelain tube glazed internally and externally and closed at each end by rubber stoppers. Through one of these passed a glass tube, making connection with a Torplér mercury pump, and through the other two glass tubes into which the leads from the thermocouple were fused. An electric resistance furnace was employed to heat the tube, and in order to prevent undue heating of the rubber stoppers the ends of the tube were water-cooled. The temperatures were determined by a thermocouple used in connection with a millivoltmeter.

Before starting an actual experiment it was thought advisable to run a blank; accordingly the tube and pump were thoroughly dried by drawing a stream of dry air through them for several hours. The end of the tube away from the pump was then sealed off and

A contribution to a general discussion on "The Occlusion of Gases by Metals," at the Faraday Society, on Tuesday, November 12.

†Thesis for Master's Degree in Science, Massachusetts Institute of Technology.

the tube exhausted and allowed to stand for 24 hours; the tube was then again exhausted and allowed to stand for a further 24 hours. At the end of this time continued working of the pump failed to pump anything out of the tube. It was next heated for nine periods of 8 hours each to a temperature of about 1,000 deg. C. and exhausted at the end of every third period. The composition and volume of the gases obtained in these experiments are embodied in Table II.

Table II.

	Volume in c.c.	CO ₂	H ₂	CO	CH ₄	N ₂
First period.....	0.84	15.48	40.00	—	19.05	25.47
Second period.....	1.15	18.25	52.20	11.22	5.48	12.78
Third period.....	1.18	4.23	73.22	13.55	5.93	3.13

No correction has been made for these gases in the appended results on the gases obtained from the various samples of steel.

In this connection it is interesting to note that Fox† found that thoroughly dried oxygen, when swept through an otherwise empty red-hot porcelain tube, persistently yielded small quantities of water—3.5 mgr. during the first hour, 0.7 mgr. from the twelfth to fourteenth hours.

A piece of one of the steels, weighing about 60 grammes and having a thermocouple inserted in one end, was next placed in the tube, the latter exhausted, and the vacuum maintained for 48 hours before starting the heating of the tube. After again exhausting the tube the experiment was commenced and continued over 10 days, the period of heating being 11 hours per day; and at intervals during each day the gas was collected and analyzed. The volume and composition of the gases are given in Table III.

In the case of the steel with blowholes, as many as possible were cut open in order to allow the gases contained in them to escape, the object of the author being to obtain the gases from the solid portion of the steel, leaving those contained in the blowholes for a future investigation.

Some further experiments were carried out to ascertain the effect of such operations as annealing and mechanical work on the volume and composition of the gases. A piece of the sound steel was annealed at a temperature of about 1,200 deg. C. and the gas extracted in the manner already described; no marked changes were observed in either the composition or volume of the gases. No numerical results are given for this experiment, since they are simply a repetition

Table III.
Sound Steel—Weight taken, 69.3 Grammes.

Temperature of Extraction. Deg. C.	Total.	Volume in c.c.						Percentage Composition.			
		CO ₂	H ₂	CO	CH ₄	N ₂	CO ₂	H ₂	CO	CH ₄	N ₂
519	6.53	0.07	6.47	0.07	0.02	0.00	1.07	97.54	1.07	0.30	0.00
600	10.67	0.19	8.44	2.00	0.07	0.00	1.78	79.10	18.74	0.65	0.00
672	12.87	0.35	8.07	4.40	0.07	0.00	2.71	62.70	34.18	0.54	0.00
688	22.91	0.75	6.96	15.02	0.12	0.03	3.27	30.38	65.56	0.52	0.13
719	12.61	0.07	4.74	7.72	0.06	0.01	0.55	37.58	61.22	0.47	0.08
765	6.71	0.02	3.35	3.26	0.05	0.02	0.29	49.92	48.58	0.74	0.29
802	4.29	0.00	2.24	1.97	0.08	0.00	0.00	52.21	45.92	1.86	0.00
862	4.59	0.05	2.24	2.22	0.08	0.00	1.08	48.80	48.36	1.74	0.00
936	5.04	0.03	2.53	2.42	0.07	0.00	0.59	50.19	48.01	1.38	0.00
979	5.64	0.01	2.83	2.75	0.04	0.01	0.17	50.17	48.75	0.70	0.17
Totals	91.86	1.54	47.77	41.83	0.66	0.07					

Steel With Blow-Holes—Weight taken, 63.2 Grammes.

530	3.28	0.09	3.04	0.06	0.05	0.04	2.74	92.68	1.82	1.52	1.22
603	2.96	0.06	2.70	0.08	0.06	0.06	2.02	91.21	2.70	2.02	2.02
681	4.36	0.06	2.16	2.01	0.15	0.03	1.37	48.39	46.10	3.45	0.69
696	5.45	0.02	1.49	3.85	0.05	0.04	0.36	27.34	70.64	0.91	0.73
720	5.04	0.03	1.84	3.11	0.06	0.00	0.59	36.50	61.70	1.19	0.00
762	3.80	0.02	1.87	1.81	0.09	0.01	0.52	49.21	47.63	2.37	0.26
825	3.98	0.02	2.01	1.87	0.07	0.01	0.50	50.50	46.98	1.75	0.25
893	4.24	0.03	2.18	1.93	0.10	0.00	0.71	51.41	45.51	2.35	0.00
944	4.48	0.02	2.32	2.08	0.05	0.01	0.45	51.78	46.42	1.11	0.22
1.046	4.50	0.02	3.38	1.05	0.05	0.00	0.44	75.11	23.33	1.11	0.00
Totals	42.09	0.37	22.99	17.85	0.73	0.20					

Soft Steel Ingot—Weight Taken 66.6 Grammes.

411	2.79	0.04	2.68	—	—	0.07	1.43	96.05	—	—	2.51
525	2.37	0.01	2.33	0.01	—	0.02	0.42	98.31	0.42	—	0.84
609	6.05	0.01	5.90	0.13	0.01	0.00	0.16	97.52	2.15	0.16	0.00
667	4.92	0.08	4.58	0.27	0.01	0.00	1.62	93.09	5.48	0.19	0.00
720	7.26	0.31	3.64	3.29	0.02	0.00	4.27	50.13	45.31	0.27	0.00
786	17.19	0.24	5.24	11.63	0.07	0.00	1.40	30.48	67.65	0.40	0.00
836	13.20	0.10	4.19	8.67	0.13	0.11	0.76	31.74	65.68	0.98	0.83
885	7.03	0.01	3.33	3.54	0.13	0.02	0.14	47.37	50.35	1.84	0.28
965	8.03	0.01	3.99	3.89	0.13	0.01	0.12	49.68	48.44	1.61	0.12
Totals	68.84	0.81	35.88	31.42	0.50	0.23					

Table IV.—Bar—Weight Taken, 67.7 Grammes.

Temperature of Extraction. Deg. C.	Total.	Volume in c.c.						Percentage Composition.			
		CO ₂	H ₂	CO	CH ₄	N ₂	CO ₂	H ₂	CO	CH ₄	N ₂
435	1.61	0.06	1.46	—	0.02	0.07	3.72	90.68	—	1.24	4.34
535	2.21	0.02	2.14	—	—	0.05	0.91	96.83	—	—	2.26
610	1.85	0.00	1.71	—	0.09	0.05	0.00	92.43	4.86	—	2.70
679	2.35	0.02	1.80	0.42	0.02	0.09	0.85	76.59	17.87	0.85	3.83
722	2.75	0.03	1.43	1.25	0.00	0.04	1.09	52.00	45.45	0.00	1.45
788	9.14	0.11	2.48	6.48	0.00	0.07	1.20	27.13	70.89	0.00	0.76
823	7.13	0.07	2.43	4.55	0.01	0.07	0.98	34.08	63.81	0.14	0.98
872	3.96	0.02	1.81	2.09	0.01	0.03	0.50	45.70	52.78	0.25	0.76
927	5.25	0.00	2.48	2.60	0.00	0.17	0.00	47.23	49.52	0.00	3.23
Totals	36.25	0.33	17.74	17.39	0.04	0.64					

of those already given for the same steel in the untreated condition.

Table V.

Description.	Weight of Steel in Grammes.	Volume of Gas per Gramme of Steel in c.c.	Volume of Gas in c.c.	Average Percentage Composition.						
				CO ₂	H ₂	CO	CH ₄	N ₂		
Sound steel.....	69.3	1.32	91.86	1.68	52.00	45.53	0.72	0.07		
Sound steel re- heated	4.73	1.40	66.54	1.16	49.55	45.99	2.71	0.59		
Steel with blow- holes	42.1	0.66	63.20	0.88	54.56	42.36	1.73	0.47		
Soft ingot.....	66.6	1.03	68.84	1.18	52.12	45.64	0.73	0.33		
Bar from soft in- got	67.7	0.53	36.25	0.91	49.08	48.12	0.11	1.77		

In order to investigate the effect of mechanical work, an ingot from the same cast of soft steel as

that already employed was rolled down from 9 in. square to a plate 9 in. wide by ½ in. thick, and a piece selected from a position corresponding as nearly as possible to that of the piece from the first ingot. The results of this experiment are embodied in Table IV.

In Table V the results of all the experiments are collected. From these it appears that the composition is practically the same throughout the series, but that the volume varies considerably. In the case "sound steel" and "steel with blowholes," the variation in quantity is easily explained, since the latter before and while solidifying would boil off the greater part of the gas. In the case of the "soft ingot" also which contained an outer ring of blowholes, a smaller quantity of gas might reasonably be expected when compared

(Continued on Page 163)

FOREIGN RELATIONS

FOREIGN TRADE OPPORTUNITIES.

The following foreign trade opportunities are reported in the daily Commerce Reports. Reserved addresses may be obtained from the Bureau of Foreign and Domestic Commerce, Washington, D. C., and its district co-operative offices. Request for each opportunity should be on a separate sheet and state opportunity number. The bureau does not furnish credit ratings or assume responsibility as to the standing of foreign inquirers; the usual precautions should be taken in all cases.

28245—A firm in Scotland desires to purchase steam fittings of all kinds, such as valves and cocks in gunmetal; cast iron, and steel for steam, water, gas, air, or oil. Tubes and fittings for gas, water, and steam, and pressure gauges. It also desires to secure an agency for the sale of these supplies, and where an article is patented, either of buying the patent or of manufacturing for the owner of the patent under a royalty. Reference.

28248—A company in Canada desires to be placed in communication with manufacturers of plastic or jointless firebrick. (This material is a fireclay in a moist condition to be used in the building up of special forms in boiler work, foundry work, etc.)

28280—A man in England desires to be placed in communication with manufacturers of iron and steel. Reference.

28290—An electrical supply firm in Belgium desires to be placed in communication with firms for the purchase of electrical appliances, electrical machines, machine tools worked by electricity, insulating material, conductive wire, etc. Catalogs and price lists are requested. Correspondence should be in French.

28305—A man in Norway desires to purchase iron and steel, metals, heavy hardware, machinery, electrical apparatus and supplies; light, heat, and power service, lead, and steel and copper wire and cable. Terms, cash against documents at destination. Correspondence may be in English. Reference.

28321—A man in France desires to secure an agency for the sale of hardware. Correspondence may be in English, French preferred. References.

28323—A firm in Sweden desires to purchase lubricating oil, beltings, packings, and mechanical supplies. Correspondence may be in English. References.

28330—An agency is desired by a man in Australia for the sale of galvanized iron. Reference.

28351—A company in Belgium desires to purchase all kinds of electrical goods and appliances directly from a manufacturer in this country. It also desires to act as agent for the sale of these goods. Quotations should be given f.o.b. New York. Payment to be made in New York against documents. Correspondence may be in English. Reference.

28354—A man in Denmark desires to represent American firms for the sale of iron and steel, and machinery. Correspondence may be in English.

28358—A manufacturer in Belgium desires to purchase cast steel wire for the manufacture of cables, of ordinary, extra, and of extra superior quality, diameters from 0.7 mm. to 2.5 mm. for galvanized and ungalvanized. The diameters most used are 1.8 mm., 1.9 mm., 2.0 mm., 2.1 mm., and 2.2 mm. He also states that he is in great need of hemp, spun hemp, manila and Russian hemp, as well as various oils and fats. Correspondence should be in French.

28377—A firm in Sweden wishes to purchase iron, steel and general hardware. Correspondence may be in English. References.

28382—A company in France desires to secure an agency for the sale of sheet iron for boilers and railway carriages, structural and cornice iron, round and square iron bars, and iron, steel, and brass pipe for boilers and locomotives. Correspondence should be in French. References.

28390—The manager of a firm in China, who is soon to be in this country desires to purchase piece goods, hardware and sundries.

28393—A commercial agent in Algeria desires to secure an agency for the sale of kitchen and household articles in tin, enamel, and galvanized iron; steel for construction purposes; agricultural machines; machines for cigarette making; stills; cotton goods, bleached, unbleached, and printed; silk goods; writing and wrapping paper; and leather and rubber

articles. Correspondence should be in French. Reference.

28394—An agency is desired by a man in Switzerland for the sale of building materials, plastering and painting equipment, ironware, insulating materials, industrial supplies, beltings, oils, lubricants, belting buckles, household articles, sanitary supplies, lace and colors, tapestry, chemises, and technical and special articles. Correspondence may be in English. References.

JAPANESE SHIPBUILDING PROGRAM FOR 1919.

According to the most authentic information available, 181 steamers, each having a capacity of more than 1,000 tons deadweight, aggregating 1,189,285 tons, will be built at various leading shipbuilding yards in Japan in 1919. With peace restored, many small shipbuilding concerns which have been started at various different places in this country in such rapid succession since the war and which have no strong financial backing are destined to disappear soon.

On the other hand, such large corporations as the Kawasaki Dock Company, of Kobe, the Mitsubishi Shipbuilding Company, both at Bagasaki and Kobe, the Asano Shipbuilding Company, of Yokohama, the Uraga Dock Company and several others, all representative in the shipbuilding world of this country, are now contemplating expansion on a large scale for the post-bellum trade. These big shipbuilding concerns believe themselves quite fortunate in having opportunities for employing many skilled workmen, discharged by the above-mentioned small firms recently, at most favorable conditions.

Output of the Several Firms.

Further particulars of this vast shipbuilding program for the next year in which practically all leading shipbuilding firms in this country are included are given below:

Name of concerns	No. of vessels	Aggregate dead weight tonnage
Kawasaki	37	333,000
Osaka Iron Works (Sakurajima) ..	9	83,000
Osaka Iron Works (Innoshima) ..	8	74,000
Mitsubishi (Nagasaki)	10	74,300
Mitsubishi (Kobe)	6	33,500
Uraga	12	91,260
Asano	10	88,000
Harima	8	67,500
Yokohama Dock	9	58,200
Mitsui	7	45,000
Uchida	5	34,000
Ishikawajima	6	30,000
Nitta	7	25,600
Osaka Dock	8	24,000
Asahi	4	22,000
Toba	5	19,000
Yogyo	4	17,400
Fujinagata	4	15,300
Naniwa	4	13,600
Aizawa	5	11,625
Matsuo	3	5,900
Kitsugawa	1	1,500
Ono	2	4,500
Harada	2	4,200
Kibi	2	3,900
Hakodate	2	3,200
Chitose	1	2,000
Total	181	1,189,285

Many persons who have been watching with interest the movements of K. Matsukata, president of the Kawasaki Dock Company, who returned home recently after having spent nearly three years in England, are not disappointed in their expectations. Soon after his return home Mr. Matsu-

kata announced that the capital of his firm would be increased to 50,000,000 yen (\$24,900,000), the greater part of the new shares being given to the workmen who have worked faithfully in his firm for a long time. This is not all that has been done since his return home, for another notable announcement is the establishment of the Daifuku Steamship Company with a capital of 20,000,000 yen (\$9,900,000) and also a chemical factory, equally influential, with several experts employed during his stay abroad, working in the latter firm.

EQUIPMENT AND OUTPUT OF A CHINESE SHIPYARD.

The Kiangnan dockyard is located on the Whangpo River, Shanghai. It is above both the foreign settlement and the native city. In organization it is a Chinese government shipyard, the only one doing commercial construction. Its directorate is Chinese, the managing directors being Admiral Liu and Mr. Kwong, Sr. Its technical administration is in the hands of a mixed Chinese-European staff, there being 10 English employes superintending the engineering problems. The chief engineer is an Englishman named Morgan.

Capacity Being Enlarged.

The capacity of the plant is very limited, and compared to a modern European shipyard it is antiquated. This fact, however, assumes less importance when we consider what such a plant means to China and Chinese development. The building ways line the Whangpo for several thousand feet and appear to be somewhat hampered for space. Five new ways are under construction.

Present construction consists of a 1,200-ton composite freighter (steel-framed, wood-sheathed type) which, under prevailing high prices, will cost \$400,000. Were steel plating to be used instead of the wooden sheathing there would be a difference of \$400,000 in favor of wooden construction, as an all-steel ship of this type would cost \$800,000, provided ship's plates could be had on the market. Apart from the framework, the only steel consists of plate for trimming tanks forward and amidships. When I visited the dock there were several commercial steamers under repair. A 4,000-ton Yangsze type that would now cost fully \$500,000, and a German river gunboat which had been thoroughly crippled before the Chinese government took it over.

Description of Drydock.

Then in the drydock, 523 feet long, with 20 feet of water from the sill were two ships—a 125-foot coast patrol boat, and an old Chinese government training ship which was being reconstructed as a merchantman for Shanghai Chinese interests. Four patrol boats of 125 foot length were also under construction. This drydock opens onto the Whangpo River which has 16 feet of water (mean low water) and with tides is materially deeper.

SIXTH NATIONAL FOREIGN TRADE CONVENTION.

The chairman of the National Foreign Trade Council, James A. Farrell, has issued the formal call for the Sixth National Foreign Trade Convention, to be held in the Congress Hotel, Chicago, on Thursday, Friday and Saturday, April 24, 25, and 26, 1919.

This year, says Mr. Farrell, the convention has assembled a large amount of valuable technical information, which is available to all delegates who wish to use it. This information will be furnished by the volunteer trade advisors of some of the most experienced business houses and by the representatives of the government trade agencies. A number of prominent business men of long experience in every branch of foreign trade have offered their services as volunteer advisors. The information they can give is based on per-

sonal experience and as such is doubly valuable. In addition the Department of State will coöperate by assigning to the convention some members of the consular service who will just have returned from Europe, Latin America, and the Far East. The Department of Commerce will send a number of its experts from the Bureau of Foreign and Domestic Commerce. The Shipping Board will be represented. The Pan American Union will be present to give information on their respective fields and can supply a great fund of valuable information if called upon.

TINPLATE PRODUCTION STARTED IN NORWAY.

(Weekly Bulletin, Canadian Department of Trade and Commerce, Ottawa, January 13, 1919.)

The Norwegian canned-goods exporters have been suffering considerably during the war for want of tinplates for cans. There has now been started a mill for rolling tinplates. The production for a start is calculated for 18,000 tons of tinplates per year, but it can be increased to three times this quantity. The imports of tinplates to Norway were 32,000 tons in 1912, 41,000 tons in 1915, and 29,000 tons in 1916.

DROP IN JAPANESE-EUROPEAN FREIGHT RATES.

(Consul General George H. Scidmore, Yokohama, from Japan Advertiser of December 18, 1918.)

The Nippon Yusen Kaisha has just notified shippers that freight rates on the European run will be lowered after a fortnight by 200 shillings per ton. This is due to the extremely dull trade on the run under the influence of the cessation of hostilities.

Up to the date of armistice the Japan-London rate was firmly maintained and ranged between 1,000 and 800 shillings per ton. With the conclusion of armistice cargo consignments began to fall off, as merchants stopped all new business in anticipation of declines both in the cost of merchandise and freights. Shipowners even now have very few new inquiries for space. The Nippon Yusen Kaisha has decided to dispatch seven extra liners this month, but that is intended for the complete relief of congestion of old consignments.

The present announcement of lowering freights has been made to induce shippers to revive space demand. The new rate on bulky cargo is 400 shillings, while that on notions is 500 shillings per ton. They will be applied to consignments made January and after. Rates on cargo bound for Marseille are, however, kept to the old rate of 800 shillings per ton on bulky cargo and 600 shillings per ton on notions.

PREPARATIONS FOR THE THIRD BORDEAUX FAIR.

Literature regarding the third Bordeaux fair, which is to be held from May 31 to June 15, has been received by the Bureau of Foreign and Domestic Commerce in the form of (a) application blanks for participation in the fair; (b) sample contracts for advertising space in the official catalog; and (c) pamphlets describing the plan of the buildings and their location on the Place des Quincones, presenting the advantages to buyers and sellers meeting at this point, and giving information in regard to the date of subscriptions, accommodations offered in the way of customs, furnishings, lodgings, etc.

John M. Chapman, president of the Lamontagne, Chapman Company (Inc.), 101 Park avenue, New York, is the official representative of the fair in this country, and those desiring further information are advised to get in touch with him.

Copies of the literature referred to may be obtained from the Bureau of Foreign and Domestic Commerce or its district or coöperative offices by referring to file No. 110760 a.

Some Pointers on By-Product Coke Oven Operations

ECONOMIC CONSIDERATIONS IN COKE-OVEN PRACTICE.*

Compared with the beehive coke oven, the by-product oven produces an equal quality of coke at a lower cost, uses less coal per ton of coke, and widens the range of coals available for coking. It therefore has a greater steadying influence on fluctuations in the cost of coke, and ultimately of iron.

Why Do Beehive Ovens Survive?

The economic advantage is all in favor of by-product practice, because it develops more fully the potential value of the coal and conserves our national resources. It is therefore surprising that so much coke is still made in beehive ovens. It is not the large capital cost that stands in the way, for the value of the coal saved will itself pay the interest and depreciation charges. Taking a coal yielding 60 per cent of coke in beehive ovens and 70 per cent in by-product ovens, to make 100 tons of coke 23 tons more coal would be required in the beehive oven than in the by-product; or—to carry it a step farther—if the output of a battery of 40 by-product ovens is made in beehive ovens, 16,000 tons more coal per annum would be required; therefore the value of the coal saved will pay the interest and charges. Nor is it altogether prejudice against the appearance and form of the coke. Two reasons are advanced for the survival of beehive ovens, namely:—(1) They may be started with little preparation and cost when the market is favorable, and stopped in less favorable times, whereas a by-product plant must be operated continuously (especially if linked up to the colliery or ironworks for power purposes). (2) At a particular colliery the output of coking slack may fall short of the quantity that will most advantageously carry a by-product plant through bad times. The essential complement of foremen and operative team not on tonnage rates is capable of dealing with, say, 40 discharges of coke per day, and the cost of labor per ton of coke is nearly doubled if there are only 20 discharges. A battery capable of 40 discharges will consist of 50 ovens, assuming a coking period of 30 hours. These are favorable conditions in regard to labor cost, although, of course, smaller batteries may be, and are, operated with financial success. But if a combination of interests can be brought about, the output of slack from two or more neighboring collieries may be amalgamated with advantage to each.

Location of Ovens.

When there exists no special reason for linking up the ovens to the colliery, such a combination may advantageously join the blast furnace owner and assemble the coals at the ironworks. The colliery irregularities of supply are then largely eliminated, and the ovens may be worked intensively and without those variations which rob the operation of its economies. Whereas at the colliery the coals must be absorbed as they are produced, they may be mixed at the ironworks to give a more constant average content of volatile matter and produce a more uniform quality of coke, although one or more of the constituent coals be of only indifferent coking quality.

*Abstract of paper read, November 9, before the Midland Institute of Mining, Civil and Mechanical Engineers.

Mixing Coals.

Wherever the ovens may be located, the mixing of the coal ought to receive more attention than it does at present. It is due largely to the use of inferior coking slacks without adequate mixing that some of the by-product coke produced today merits all the prejudice which attended its earliest introduction. The blast furnace manager wants coke uniform in quality, and at least constant in its imperfections. An intimate and uniform mixture of the slacks for by-product ovens is not easily made and maintained over long periods. When derived from two or more seams, the slacks are not sufficiently mixed by tipping alternate wagons into the raw coal-hopper, and by the turning over it receives in the washery and drainage bunkers. Better results can be obtained from an arrangement consisting of several under-rail hoppers fitted with revolving feed-tables drawing regulated quantities from the several hoppers on to a common belt supplying the washery.

Moisture.

It is generally agreed that washed slack should be drained for 48 hours before crushing, and that a longer period does not reduce the moisture to a degree commensurate with the cost of the additional drainage hoppers which would be required. The moisture may then be 10 to 12 per cent, or even more, according to the fineness of the slack. In coal containing 4 per cent of combined water and 10 per cent of added water, 14 tons of water is charged into the ovens for each 86 tons of coal; and, while a limited quantity of moisture is advantageous to the formation of ammonia and necessary to the process of compressing the charge, it all has to be evaporated to steam in the oven—an appliance singularly unfitted for the purpose.

Weighing.

The coal usually passes through the screens directly into the washery, and the weight of washed slack charged into the ovens is ascertained only from the coke and breeze made, based on the laboratory yield. It would be of great advantage if the washed slack could be weighed, and where a band conveyor is in use it is quite practicable to install one of the continuous type of weighing machines.

Compressing.

The stamping of charges serves to improve the quality of many British cokes. Careful tests made in Semet-Solvay ovens on coals containing from 26 to 28 per cent of volatile matter show that the weight of the charge is increased approximately 30 per cent, which is reduced by the longer coking time to a net gain in production of about 13 per cent. If it is established by trial that the quality of a coke is improved by compression, that operation is preferable in many ways to top-charging. The top of the charge has the same density as the bottom and the coke is therefore more uniform; the proportion of breeze is reduced; the charge is a constant quantity and a measure of the capacity of the plant; the capacity is maintained at a maximum independently of the skill or care of workmen; the oven being completely filled, the amount of free space on top of the charge, and consequently the degradation of by-products, is minimized; the gas off-take may be in the center of the oven length, and the path of the gases shortened; finally, except in the smaller plants, the labor cost per ton of production is definitely below that of the best system of top-charging.

NEWS OF THE PLANTS

The Smelters Steel Company, Henry Building, Seattle, Wash., has commenced the construction of a new electric furnace on the commercial waterway, British Columbia. The plant will consist of four modern furnaces, with capacity of about 30 tons of high-grade iron per day. It will handle material from the company's iron ore mines in British Columbia, and will be thoroughly up-to-date in all particulars; considerable equipment for the new plant has been purchased. G. Lewis Casey is president.

The Belfont Iron Works Company, Ironton, O., is planning to install new equipment at its blast furnace during the coming year. It is proposed to increase the present capacity of the plant about 50 per cent. The new installation will comprise a gas washer, slag pit equipment, and other apparatus.

The Bethlehem Steel Corporation, Bethlehem, Pa., has arranged for an appropriation of about \$20,000,000 for improvements and extensions in its various steel plants during the coming year. The majority of this fund will be used for the completion of the company's large steel plant at Sparrows Point, Md., including plate mill and other works departments. It is proposed to bring the aggregate capacity of the company's plants up to about 3,000,000 tons of steel per annum, with rolling mills and other finishing works to provide facilities for handling this amount of material for the manufacture of commercial products. The company is now making repairs at one of its rolling mills at the Steelton, Pa., works.

The Strong Manufacturing Company, Sebring, O., is considering the construction of a new sheet mill at its local works. The plant will be designed to manufacture sheets for the production of enamel ware, and is to be constructed in connection with a new addition to the enamel ware plant to double the present capacity of the works.

The Weirton Steel Company, Weirton, W. Va., is making rapid progress in the construction of a new blast furnace at its local plant. The unit will have a capacity of about 600 tons and will be used for the production of pig iron.

The Tennessee Coal, Iron & Railroad Co., Fairfield, Ala., is planning to place new mills now in course of erection in service at an early date. Work on the 110-inch plate mill has now been completed, and this department placed in operation. A 40-inch blooming mill and 26-inch shaping mill are now nearing completion, and will be placed in service at an early date following the installation of machinery, and considerable of which is now on the site. George G. Crawford is president.

The Ordnance Department, Washington, D. C., has commenced the construction of a new plant at Charleston, W. Va., to be equipped as an armor plate works for the Naval Department. Contract has been awarded to the American Bridge Company, 42 Broadway, New York, for the construction of a number of buildings for the new works. These various structures will average from 1,200 to 1,600 feet in length and exclusive of equipment are estimated to cost over \$2,000,000. With machinery and operating equipment, the entire plant will represent an investment of close to \$15,000,000, an original appropriation of \$11,000,000 being increased to this amount for the purpose. The plant will be operated in conjunction with the other steel works of the government at this location, which are used for the manufacture of guns and other ordnance work.

The Ford Motor Car Company, Detroit, Mich., is making rapid progress in the erection of its new steel works on the River Rouge, to be used for the production of material for Ford automobiles, trucks, and tractors. The plant will consist of two blast furnaces, each with capacity of about 600 tons per day, a coke works, with by-product coke plant, foundry, and other structures, as well as a large electric power plant for works operation. The first blast furnace unit with auxiliary equipment, including three hot blast stoves, is now nearing completion, and is expected to be ready for operation at an early date. Within the next few weeks the coke plant, with by-product equipment, will also be ready for active service, with capacity of about 12,000,000 feet of gas daily. The foundry to be erected, will be about 250x960 feet, and will be located near the blast furnaces. It will be fully equipped for all features of work, and will be supplemented by a number of subsidiary buildings for general production. The electric power plant will be erected during the coming spring, and will have a capacity of about 32,000 kilowatts, divided into two turbo generator units of 20,000 kw, and 12,000 kw, respectively. This plant, with boiler house, etc., is estimated to cost over \$2,000,000. The entire works are expected to represent a total investment of over \$40,000,000, and of which amount about one-quarter has now been expended. The plant will use iron ore from the Lake Superior district.

The Wellston Iron Furnace Company, Wellston, O., is making improvements at its blast furnace plant. No. 1 furnace has now been relined and blown in. No. 2 furnace will be relined and improved, and is expected to be ready for service by the end of March.

The Aluminum Rolling Mill Company, Cleveland, O., has completed its new plant on Ivanhoe Road, and will immediately commence operations for the production of rolled aluminum sheets in various sizes, as well as refined aluminum. The initial plant comprises a main building, about 90x350 feet, and is provided with one furnace with capacity of 8,000 pounds, and six stands of rolls. The present plant will have a capacity of over 250,000 pounds of material a month, and has been designed to allow for the construction of additions for increased capacity as required.

The Thomas Iron Company, Wharton, N. J., is making extensive improvements in its local properties, including the construction of a new concentrating mill for increased production. At its blast furnaces at Hokendauqua, Pa., it is planned to install considerable new equipment during the coming months; this work will include a new casting machine for pig iron production, a new boiler plant, water treating plant, and other work. The present plant has a furnace capacity of over 20,000 tons a month. During the past year numerous improvements have been made and equipment installed to bring the works up to the highest point of efficiency.

The American Sheet & Tinplate Co., Pittsburgh, Pa., is now making improvements and extensions at a number of its plants. At Gary, Ind., 24 additional tin mills are now in course of erection, and will be supplemented by a number of auxiliary structures for works operation. At the Chester works one new plate mill is now being constructed, while a like condition prevails in regard to the Cambridge works, which is also building one new tin plate mill. These latter plants will be completed at the earliest possible time.

INDUSTRIAL RELATIONS

INDUSTRIAL USE AND LIMITATIONS OF RESPIRATORS, GAS MASKS, AND OXYGEN BREATHING APPARATUS.

During the last year the Bureau of Mines, Department of Interior, has received many inquiries regarding the use of army gas masks in the industries for protection against poisonous and irritating gases. These inquiries show a general belief on the part of the public that this type of mask will protect the wearer under all conditions against any gas whatsoever, even in absolutely irrespirable air to the exclusion of the more cumbersome mine rescue breathing apparatus. This erroneous belief will no doubt be further confirmed by millions of discharged soldiers who have been trained in the use of the gas mask and have been taught that it gives them absolute protection against all gases used in warfare or likely to be used. These men will not realize that out in the open air of the battlefield, the percentage of gas in the air can never be anywhere near as large as may occur in the confined spaces of a factory operation. A mask may afford complete protection under outdoor conditions and break down at once when used indoors where a gas container has burst and filled the room with a greater concentration of gas. It must also be remembered that the absorbents in the army respirator, which filter out the poisonous gas, are especially designed for the gases used in warfare, and as a matter of fact do not protect against the more common industrial gases as, for example, illuminating, natural, producer, and blast furnace gas.

The army gas mask never should be used in mines, because of the uncertainty there is of the kinds and amounts of gases in the atmosphere and liability of insufficient oxygen to support life.

In view of these limitations of the Army gas mask, which, if not realized, will lead to serious accidents and fatalities, the Bureau of Mines is issuing this brief statement of the industrial use and limitations of the several dust respirators, gas masks, and oxygen breathing apparatus.

Army Gas Mask.

The Army gas mask consists of a face piece of rubber and cloth fabric, containing eye pieces and connected by means of a flexible rubber tube to a canister containing charcoal and soda-lime for filtering out the poisonous gas from the inhaled air. The canister is supported in a knapsack slung from the neck.

The Army gas mask is by no means the unusual protective appliance that it is popularly believed. It does not afford universal protection against all gases, nor can it ever be used safely in low oxygen atmospheres. It furnishes no oxygen to the wearer and can only remove comparatively small percentages of poisonous gas from inhaled air, usually less than 1 or 2 per cent. Higher percentages will immediately penetrate the canister and "gas" the wearer. The standard Army gas mask will furnish protection against percentages not exceeding 2 per cent of the following gases in air: Sulphur dioxide, hydrogen sulphide, chlorine, carbon bisulphide, nitrogen peroxide, aniline vapor, benzyl bromide, benzyl chloride, chloracetone, chlorpicrin, hydrogen chloride, phosgene, sulphur chlorides, xylol bromide, stannic chloride, titanium tetrachloride, and silicon tetrachloride.

It will be seen from the above that the field of usefulness

of the Army mask is confined to certain of the chemical industries, around smelters and roasters where sulphur fumes are given off and in the industries using chlorine and bleaching powder. The Army canister also contains cotton filter pads which remove irritating and poisonous dusts, which increases its usefulness around smelters where sulphur and arsenic fumes must be removed.

The Army mask furnishes no protection whatever against carbon monoxide. This is the poisonous constituent of blast furnace, producer and illuminating gases, and of mine gases after fires and explosions in coal mines. Carbon monoxide is also likely to be present in ordinary fire fighting conditions met by fire departments. Moreover, in all of these cases there is likely to be a deficiency of oxygen. Therefore, for adequate protection against these conditions the oxygen breathing apparatus must be used, and reliance on the Army mask may be fatal.

The Bureau of Mines is working on a carbon monoxide mask and hopes to develop one that may be used in the future for low concentrations, of this gas, but such a mask is not now available.

Ammonia is another gas that will penetrate the standard Army canister. However, a special chemical may be placed in oxygen. Such atmospheres are encountered in mine refrigerating plants.

Oxygen Breathing Apparatus.

The self-contained oxygen breathing apparatus can never be displaced by the gas mask for use in atmospheres deficient in oxygen. Such atmospheres are encountered in mine rescue work, in gas mains, blast furnace stoves, gasoline tanks, etc. Aside from the lack of oxygen, carbon monoxide is also present, for protection against which the Army mask is useless.

The oxygen breathing apparatus must also be used instead of the Army gas mask wherever there are large quantities of irrespirable or poisonous gases, as for example, in entering a gasoline tank containing some residual liquid, or similar tanks, towers, and other closed spaces. The concentration of vapors produced by volatile liquids in closed containers is too high to be entirely removed by gas mask absorbents. The only recourse in such cases is a self-contained appliance in which the wear does not breathe any of the irrespirable atmosphere.

Importance of Expert Advice on Protective Breathing Appliances.

Owing to the many factors entering into the use of protective respiratory appliances, the importance of competent advice on the selection and use of such appliances cannot be over estimated. The fact that the Army and Navy used gas masks has been widely disseminated and its significance is likely to be misunderstood, especially by men who have had some training in their use. It also should be made known that both the Army and Navy used the oxygen breathing apparatus in its appropriate place.

In connection with the Bureau of Mines' work of safeguarding the health of miners and workmen in the metallurgical industries, a general investigation of respirators, gas masks, and breathing appliances is being undertaken at the Pittsburgh Experiment Station of the Bureau. This research will be conducted by experienced chemists and engineers who had charge of gas mask research in the bureau's war gas investigations and subsequently in the Research Division of the Chemical Warfare Service, U. S. A.

The industrial respirator investigation will include:

1. Advice on the suitability of the standard army gas mask for use in various industrial gases.
2. Approval of industrial gas masks and respirators when properly submitted to the bureau by the manufacturer in accordance with a schedule to be announced later.
3. Instruction of workmen at plants in the use of masks and respirators in a manner similar to that now being given by the bureau in the use of oxygen breathing apparatus.

PRODUCTION TOPICS

PRODUCTION OF FUEL BRIQUETS IN 1918.

The production of fuel briquets in the United States in 1918 was 477,235 net tons, valued at \$3,212,793, an increase, compared with 1917, of 70,379 tons, or 17 per cent, in quantity, and of \$978,905, or 44 per cent, in value. The production in 1918, which represented the results of the third successive year of material progress in the industry, was the highest yet recorded. It was more than double that in 1915.

In the Eastern States production increased 59 per cent, in the Central States 37 per cent, but in the Pacific Coast States it decreased 36 per cent.

The number of plants in operation in 1918 was one less than in 1917. Three of the plants that were operated in 1917 were idle in 1918—those of the Denver Coal By-Products Company (formerly the American Coal Reduction & By-Products Co.), in Colorado; the Johnson Fuel Company, in North Dakota, and the American Briquet Company, in Pennsylvania. Two new companies, at Trenton, N. J., began operations in 1918, the Fuel Briquet Company, and the Trent Brick Company. The Belgian Coal Briquette Company, of New York City, and the Anthracite Briquet Company, of Sunbury, Pa., expect to begin operations in 1919.

Of the 12 plants in operation in 1918, six used anthracite as a raw material.

PRACTICAL POINTERS ON HEATING FURNACES.

(Continued from Page 155)

appear the temperature is then brought up to a wash heat or welding heat, whereby the cracks can be readily closed. It is preferable, from the manufacturer's standpoint to use a furnace in which a wash heat can always be procured. With certain stock of alloy steels, such as billets and slabs that can be rolled, a continuous furnace would be ideal, as the charging end of this type of furnace is usually around 700 to 800 degrees F., but the ordinary continuous furnace cannot be used on account of not being able to procure a wash heat and at the same time prevent the stock from coming in contact, which would naturally result in it freezing or welding together. In designing a heating furnace for heavy work—for instance, a furnace used by such concerns as the Erie Forge Company, where it is common practice to heat ingots up to 62 inches in diameter—the design must be such that the stock, which is often of considerable length, can be heated in sections. This requires a furnace of considerable height so that the flame or gases can pass below the stock as well as above it. The time required to heat material of this size is figured out in our office in the following manner and based upon our actual practice. An ingot 62 inches in diameter, having a radius of 31 inches, requires the furnace temperature to be maintained at around 2,000 degrees F. This temperature will permeate to a depth of $\frac{1}{8}$ inch in five minutes, and 31 inches being equivalent to $248/8$, this multiplied by 5 would give 1,240 minutes—or 20 hours and 40 minutes. I find that with a stoker-fired furnace, the fuel consumption for this class of work runs between 700 and 750 pounds of coal per ton of product. This rule holds good for all heavy stock. In order that the ingot may be heated in sections, a large opening is provided on each side of the furnace. The ingot is set up on a pedestal support on the outside of the furnace. If the end is to be heated, a cast-steel block is placed on the hearth for end support. Doors are not

used on this type of furnace; but after the ingot has been charged, the openings of the furnace are closed up with brick and sealed. For work of this nature a 12 to 18-inch space is allowed between the ingot and the hearth, and a 10 to 12-inch space between the top of the ingot and the crown. If the ingot is of smaller diameter than the maximum size for which the furnace is designed, the extra space is always left at the bottom instead of at the top. There are no special features connected with the design of this type of furnace, excepting that the combustion area must be sufficient to heat readily the maximum sized stock. A waste-heat boiler is usually built in connection with this type of furnace, and provision made to by-pass the boiler, so the furnace can be operated independently when desired.

"There is a type of heating furnace used for forging and press work, which was designed for 16 by 16-inch ingots. Instead of this furnace being charged or drawn until it was either full or empty it was desired to keep the hearth full at all times—that is, immediately after a hot ingot is withdrawn, a cold one is charged to take its place, thereby utilizing the hearth area continuously; precautions being taken to prevent a cold ingot affecting a hot one. A common hearth furnace was used, with a continuous bridge wall at the rear and one common combustion chamber beyond the bridge wall. The front of the hearth is provided with three or four doors and a partition wall run straight through the hearth of the furnace from the center of each door-jamb to the bridge wall and up to within a few inches of the skew-back line; thus dividing the hearth into compartments, with one common crown over all three or four compartments. These dividing walls prevent a cold ingot from having any effect on a hot one which is ready to draw.

INVESTIGATION OF GASES OCCLUDED IN STEEL.

(Continued from Page 157)

with the sound steel. It is also evident that a mechanical operation such as rolling squeezes out a very considerable portion of the gas, which in the present case amount to about one-half.

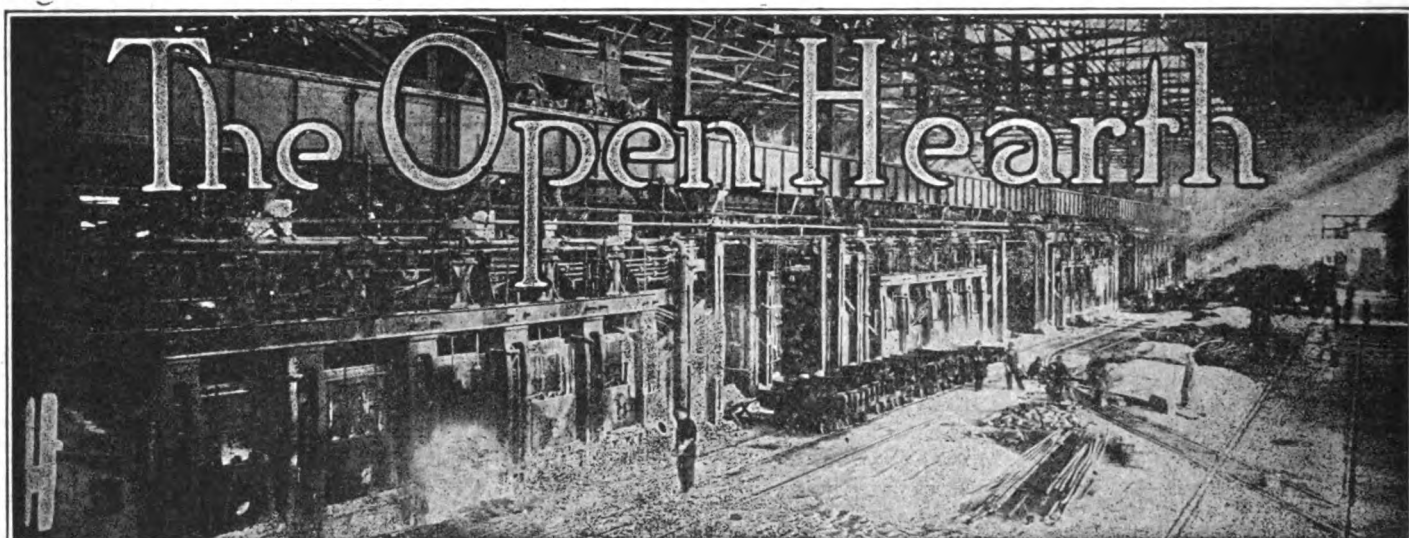
The thermal critical points of these steels occur at the following temperatures:

	Ac ₁	Ac ₂	Ac ₃	Ar ₁	Ar ₂	Ar ₃
	deg.	deg.	deg.	deg.	deg.	deg.
Sound steel and steel with blow-holes		746			693	
Soft steel ingot and bar.....	722	758	867	682	760	846

With the hard steels hydrogen reaches a maximum rate of evolution at 600 degrees, and below this temperature constitutes the greater part of the gas given off. Carbon monoxide is slowly evolved from the beginning of the experiment and reaches its maximum rate of evolution at 688 degrees, a temperature which agrees fairly well with that of the Ar₁ point.

With the soft steel hydrogen again forms the greater portion of the gas collected at temperatures up to 660 degrees and presents a maximum rate of evolution at 609 degrees. It, however, differs from the hard steel in that it has a further maximum at 786 degrees, the temperature at which the carbon monoxide also reaches its maximum rate of evolution. This latter temperature is approximately midway between the Ar₂ and Ar₃ points.

Whether these gases are the ones evolved from the steel or are formed by interaction between those actually evolved in a problem that still demands solution.



W. W. Butler has been elected president of the Canadian Car & Foundry Co., Montreal, Quebec, Can. Mr. Butler was formerly connected with the American Car & Foundry Co., and was vice president of the American Steel Foundries. He is also president of the W. W. Butler Company, Ltd., and director of the Page Hersey Iron, Tube & Lead Co.

✓ ✓

C. W. Simonds has resigned as superintendent of the wheel plant of the Cambria Steel Company, Johnstown, Pa.

✓ ✓

H. R. Shick has been appointed blast furnace superintendent of the Cambria Steel Company, Johnstown, Pa. Mr. Shick was formerly blast furnace superintendent of the Pittsburgh Steel Company at Monessen, Pa.

✓ ✓

Lieut. J. H. Schuler, formerly connected with the powdered coal department of the Fuller-Lehigh Company, and for the past year in the Ordnance Department of the United States Army, has been released from service. Mr. Schuler has been actively engaged in metallurgical work in the steel industry and has had considerable experience particularly in heavy forging work and with fuel problems.

✓ ✓

Warren Worthington, formerly general superintendent of the Donner Steel Company at Buffalo, is now a special engineer in charge of steel mill construction with the American Steel Export Company, New York.

✓ ✓

D. D. Peden, in the absence of E. A. Peden, who is in France, is directing the Peden Iron & Steel Co., Houston, Tex.

✓ ✓

J. V. Wiesman has been appointed assistant general superintendent of the Kokomo Steel & Wire Co.

✓ ✓

Peter M. Lorenz is now district sales manager for the Indiana Steel Company, Chicago.

✓ ✓

George Everton Dix, is now associated with the Consolidated Steel Products Corporation at New York. Mr. Dix has been connected with the steel industry for a number of years, having been associated with the Carnegie Steel Company, the Central Steel Company and the Midvale Steel Company.

✓ ✓

Mark Workman, president of the Dominion Iron and Steel Corporation, Sidney, N. S., has sailed for Europe concerning reconstruction plans.

John G. Rumney has been re-elected president of the Detroit Steel Products Company, of Detroit.

✓ ✓

A. J. McDonald has been appointed sales manager of the Lebanon Steel Foundry, Lebanon, Pa. Mr. McDonald was formerly associated with the Marlin-Rockwell Company.

✓ ✓

W. W. Wallace has been appointed steam and hydraulic engineer with the Pittsburgh Crucible Steel Company, Midland, Pa. He was formerly associated with the Hussey-Binns Steel Company.

✓ ✓

F. A. Sindeband of Robert Grant, Woolworth Building, New York, has sailed for Shanghai where he will establish a Far Eastern office.

✓ ✓

J. H. Fitch, Jr., is now assistant general sales manager of the Liberty Steel Company, Warren, Ohio.

✓ ✓

Lewis D. McClaren, recently released from the United States Navy Department where he was metallurgist and chief of steel production and inspection has become associated with the Chicago office of Rogers, Brown & Co. Mr. McClaren was connected with the Illinois Steel Company for a number of years.

✓ ✓

W. H. Cameron, general manager of the National Safety Council, since the beginning of this organization, has resigned to accept the position of manager of the Industrial Relations Division of the Eastman Kodak Company. No small share of the remarkable growth of the National Safety Council is due to the energetic efforts of Mr. Cameron.

✓ ✓

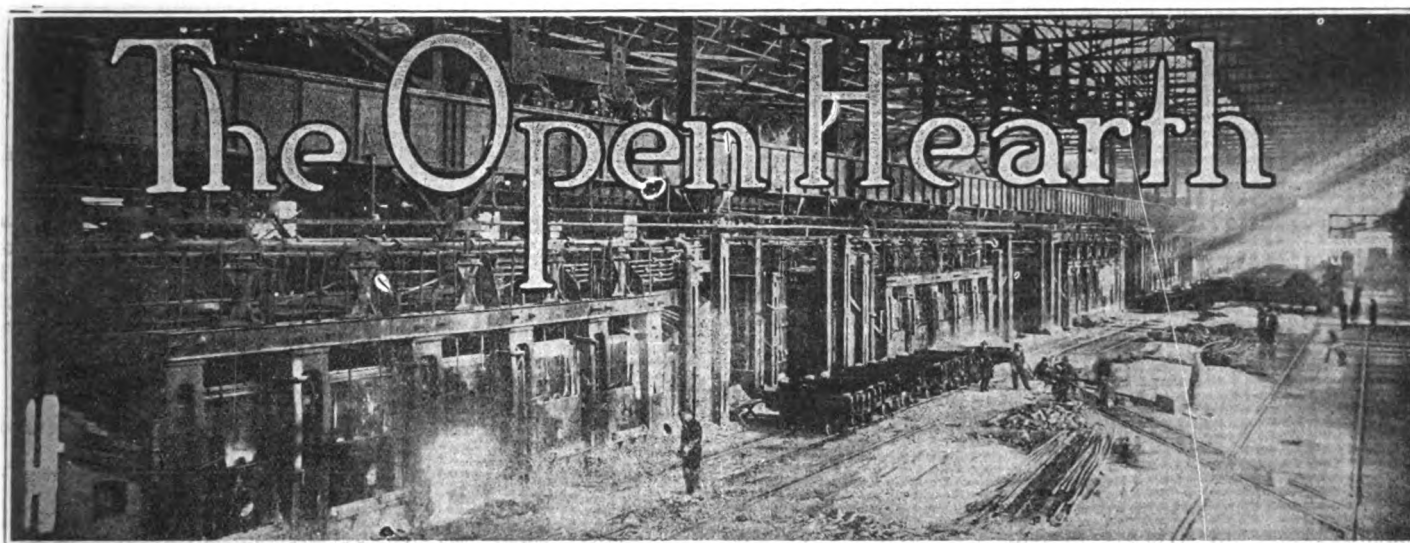
J. H. Van Campen is now steel plant engineer for the Timken Roller Bearing Company, Canton, O. Mr. Van Campen was formerly associated with the Bethlehem Steel Company and the Weirton Steel Company.

✓ ✓

John C. Wallace, Jr., for a number of years connected with the iron and steel industries on the Pacific coast in the position of purchasing agent for the Pacific Coast Steel Company, has resigned. He will conduct a sales business in iron and steel production in Pittsburgh.

✓ ✓

W. H. Eshleman is now plate mill superintendent of the Brier Hill Steel Company, Youngstown, O. Mr. Eshleman was formerly in charge of the plate mill of the Sharon Steel Hood Company.



K. E. Humbert of the firm of Perin & Marshall, New York, has just returned from India where he has been connected with some improvement work of the Tata Iron & Steel Co. C. E. Perin and M. A. Marshall are in Sakchi, India, at the present time.

✓ ✓

E. W. Patterson, superintendent Warner Iron Company furnaces at Cumberland Furnace, Tenn., has resigned to accept the position as general manager of the Gooch Coal Mining Company at Davidson, Tenn. T. T. Kendrick, assistant superintendent of the Central Iron & Coal Co., Holt, Ala., will be the superintendent of the Warner Iron Company, succeeding Mr. Patterson.

✓ ✓

Lester E. Armstrog has accepted a position as advisory engineer with the Powdered Coal Engineering & Equipment Co. of Chicago. Prior to his service in the air branch of the Army, Mr. Armstrog was associated with Babcock & Wilcox.

✓ ✓

Frank E. McIntyre is now vice president and general manager of the new Hercules Steel Casting Company, an electric steel foundry in Milwaukee. Mr. McIntyre was formerly associated with the National Steel Foundries, Milwaukee.

✓ ✓

John F. Nealis, who recently received his discharge from the aero observers branch of the service, is now associated with the Powdered Coal Engineering & Equipment Co., of Chicago, as advisory engineer. Mr. Nealis formerly had charge of research work for the United States Steel Corporation.

✓ ✓

A. A. Serva, formerly connected with the General Electric Company's plant at Fort Wayne, Ind., has taken an official position with E. A. Langenbach, president and general manager of the Berger Manufacturing Company.

✓ ✓

F. H. Lewis, formerly connected with the Midvale Steel and Ordnance Company, has accepted a position as manager of the order and shipping department of the Jones & Laughlin Steel Company, Pittsburgh.

✓ ✓

Alexander D. Darragh, formerly connected with the Carnegie Steel Company, and during the past year and a half, in the quartermasters department as a first lieutenant, has become connected with a structural and bar division of the Consolidated Steel Corporation.

Freyn, Brassert & Co., Engineers, Peoples Gas Building, Chicago, announce the appointment of Wyman Eaton, as chief engineer, taking effect February 15, 1919. Mr. Eaton was formerly connected with the engineering offices of Julian Kennedy, Youngstown Sheet & Tube Co., William Tod Company, Corrigan McKinney Company, and has recently resigned his position of engineer in charge of the rolling mill work of the Mesta Machine Company to take up his new duties.

✓ ✓

S. P. Adams is in charge of the new Chicago office of the Ashland Fire Brick Company, Ashland, Ky.

✓ ✓

At the annual meeting of the stockholders of the Wellman-Seaver-Morgan Company at the general offices of the company in Cleveland on February 18, the retiring board of directors was re-elected. The board consists of Edwin S. Church, F. E. Borton, W. H. Cowell, F. B. Richards, S. T. Wellman, E. H. Whitlock of Cleveland, S. H. Pitkin, Francis Seiberling, and F. A. Seiberling of Akron. At the annual meeting of the board of directors called immediately after the meeting of the stockholders, the following officers were elected: Edwin S. Church, president and general manager; S. H. Pitkin, vice president; George W. Burrell, second vice president; W. H. Cowell, secretary and treasurer.

G. W. Burrell, who was elected second vice president, has been in the continuous employ of the Wellman-Seaver-Morgan Company for 21 years. He will have entire charge of the company's works both at Cleveland and Akron. He was born in 1871 and attended the Cleveland public schools. Leaving school at the age of 14, he learned the machinists' trade and worked in machine shops for five years, during which time he studied nights in preparation for college, entering the Ohio State University in 1891, where he took the three years' course in mechanical engineering. He entered the employ of the Wellman-Seaver-Morgan Company in 1898 and has held the following positions: Draftsman, 3 years; inspector, 6 months; chief inspector, 6 months; assistant purchasing agent, 6 months; assistant secretary, 6 months; assistant works manager, 14 years; manager of works since May, 1917. Elected second vice president by board of directors on February 18, 1919.

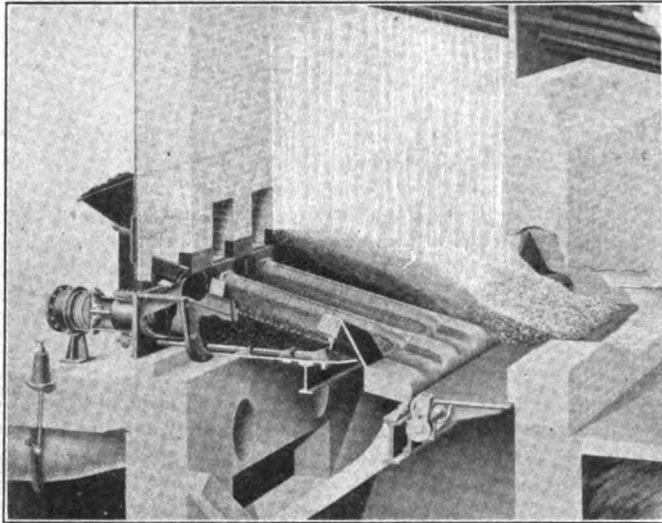
✓ ✓

James Williams has been appointed assistant superintendent of the central furnaces of the American Steel & Wire Co., at Cleveland. Mr. Williams, who was formerly general foreman, succeeds C. S. Forkum, who is now superintendent of the Donora furnaces.

WITH THE EQUIPMENT MANUFACTURERS

NEW AUTOMATIC UNDERFEED STOKER.

The Under-Feed Stoker Company of America has developed and brought out some distinctive features in their Jones automatic cleaning underfeed stoker. This stoker, designed to be self-cleaning and for high duty, embraces features making it efficient, flexible and economical. The coal hopper is located directly in front of the stoker. Coal is fed into this hopper either by hand or by gravity from the storage bins. A steam cylinder is mounted immediately below the hopper and in front of each retort, and a ram is connected to the piston of this cylinder. When steam is admitted into the cylinder through the automatic control valves, this ram is drawn outward and a charge of coal falls into the ram case. The automatic control valve reverses the stroke and the charge is forced into the retort or coal magazine. A rod is connected to the ram and travels through the front end of the retort below the ram with each operation of the steam piston. On this rod inside



Stoker showing hopper, pusher rod, steam cylinder, ram, blast gate, tuyeres, retort, dead plate and dump plate in position.

the retort are bolted two pusher blocks so that the coal is carried upward and rearward with each stroke of the ram.

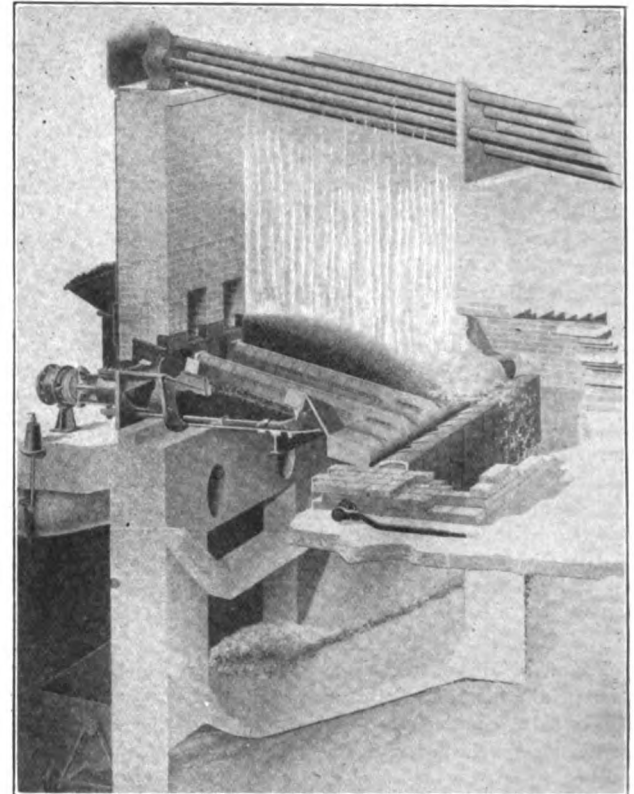
No moving part is exposed to the fire and the only movement is the straight quick thrust of the ram and pusher blocks buried deep under green coal, a condition that insures continuous operation and removes the liability of shut-down. The upward and rearward travel of the coal caused by the positive thrust of the ram, insures a continuous breaking-up and automatic slicing of the fire as well as thorough mixing of air and gases.

The intermittent movement of the ram and pusher blocks previously explained, carries the whole fuel bed slowly toward the rear. Before the fuel bed reaches the dump plate at the rear, the coal is entirely burned and there is nothing left but dead ash. This gradual movement of the fuel bed keeps the fire clean of all ash and refuse. Dropping the balanced dump plate drops the ashes into the sealed ash pit below. This operation is necessary only at occasional intervals and is simple and easy to perform.

Particular emphasis should be placed on the fact that the gradual movement of the fuel bed toward the dump plate is not a gravity movement. The slope of the retorts is not sufficient to cause the ash and refuse to slide or roll toward the dump plate. It is impossible for the coal to avalanche.

Prevention of Clinker.

The intermittent breaking-up and rearward movement of



Method of operation and important parts of Jones "A-C" stoker with dump plate dropped.

the fuel bed caused by the quick, positive action of the steam ram and pusher blocks prevent the formation of large clinkers. This is done very successfully as shown by actual test where 85 per cent of the total refuse passed through a 2-inch sieve and 94 per cent through a 4-inch sieve. An analysis of the ash shows a negligible amount of combustible.

Due to their design, the side tuyeres prevent the formation of clinker on the side walls, by keeping the bed of fuel away from the walls for a considerable height above the top of the retort. Also, due to the air circulation, no clinkers adhere to these tuyeres. There are no clinker formations on the bridge wall because the fuel is practically all consumed by the time it reaches the dump plate.

The steam pressure itself automatically controls the air supplied to the fire through the tuyeres and also the coal supplied to the retorts. Should the steam pressure drop slightly, both the air pressure and coal supply are in-

WITH THE EQUIPMENT MANUFACTURERS

creased. If the steam pressure goes up, the air pressure and coal supply are decreased in proportion.

The controlling valve is an important and distinctive feature of all Jones underfeed stokers. It is installed on the steam line to the stoker cylinder and has eight rates of operation. This permits of any desired speed of coal feed for the battery of stokers. Moreover, any retort of the battery may be operated at a different rate from any other retort—a highly valuable feature since it gives absolute control of the fire.

The length of stroke of the pusher blocks may be adjusted to meet any fuel condition encountered by the adjustment of a pin on the connecting bars below the ram outside the furnace. The pusher blocks may also be set at different points on the pusher rod. These adjustments permit any desired rate of speed and thickness of fuel bed.

Fires are easily banked, and held any length of time, by feeding in a supply of coal with the ram and shutting off the air and steam supply to the stoker.

COMPACT MULTI-SPEED MASTER CONTROLLER.

A new multi-speed full reverse master controller that is smaller than previous designs and which is especially adapted for use in connection with steel mill and crane controllers, is shown in the accompanying illustration. It will be found especially useful in installations where the operator's attention should not be diverted from the work or machine and where space is limited. An internal gear drive, which is entirely closed but which is readily accessible by



New compact full reverse multi-speed master controller.

the removal of four screws shown in the lower portion of the operating handle, eliminates the liability of accident to operators through the catching of fingers or clothing in the bevel gears usually employed in straight line drive controllers. This master may be mounted horizontally or vertically, the former permitting straight line movement of the handle and the latter, a radial movement. A centering latch operated by a button in the handle indicates to the touch the "off" position of the master, while a strong notching spring is used to indicate the five positions in either direction. A maximum of 12 fingers may be mounted on the fingerboard, using six in one direction of rotation and six in the other. The new controller, although very small and compact, is so designed that by the removal of two bolts the entire fingerboard may be taken from the frame, while the removal of three bolts allows the entire shaft and contact fingers to be withdrawn. Inspection, renewals, and repairs, are therefore easily effected. The construction of the fingerboard and drum follows the C-H standard, in that the fingers and segments are clamped to square insulated steel shafts, and adjacent contact points are separated from each other by arc barriers. This master controller is a new development of the engineering department of the Cutler-Hammer Manufacturing Company of Milwaukee.

VENTILATORS AND FIRE DOORS.

The great demand in modern industrial building has tended toward introducing more safety features than heretofore. More attention is being given to welfare, which has resulted in increased ventilation efficiency. To meet this



Fig. 1—Merchant and Evans Star Ventilator.

demand the Merchant & Evans Co., of Philadelphia, has given special attention to fire doors and shutters, and to ventilators. The Merchant & Evans Co. "Star" ventilator was adopted as a war standard by the United States government, on account of its simplicity of construction and its efficiency. This ventilator was adopted after rigid tests had been

made. A great many "Star" ventilators are in use on buildings of every possible description or character of construction throughout this country and Canada. This type of ventilator is shown in the accompanying illustration.

The Merchant & Evans "Almetl" fire doors and fire shutters, acknowledged as much superior to tinclad wood core

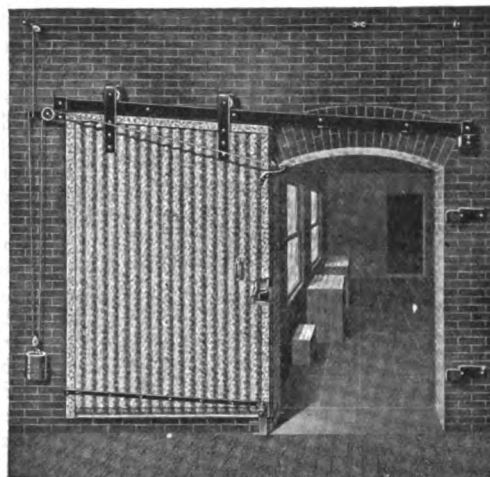


Fig. 2—Modern type of fire door.

fire doors and shutters, are not only fully approved and labeled by the Underwriters' Laboratories of Chicago, and fully approved by the Factory Mutual Laboratories of Boston, but are additionally endorsed, recommended or approved by 250 officials, directly interested in fire protection and prevention work and are likewise approved and used by the United States government, for use in such buildings as the Merchant Shipbuilding Corporation, Detroit Shipbuilding Company, Pusey & Jones Co., also the United States government arsenals, Panama Canal buildings, and air nitrate plants.

A Merchant & Evans fire door is shown in Figure 2. In designing the doors proper provision is made for expansion and contraction without distorting the frame, and where necessary on account of size the doors have intermediate braces.

Trade Notes

The Heine Safety Boiler Company, St. Louis, Mo., has just completed the printing of the latest edition of their "Boiler Logic," an 86-page treatise on steam boilers. This treatise covers the following topics:

1. Some Fundamental Considerations of Boiler Design—(a) Furnace Design Requirements, Mixing, Time, Temperature. (b) Heat Transmission from Fire by Radiation. (c) Heat Transmission by Convection. (d) Heat Transmission Through Tubes and to Water.

2. Practical Baffling of Water Tube Boilers. (a) Flexibility of Design. (b) Leakage and Cost of Repairs and Renewals. (c) Active and Inactive Surface. (d) Ease of Cleaning Soot and Ash Deposits.

3. Heine Boilers for Different Fuels—Hand Firing with Bituminous Coal; Hand Firing with Anthracite Coal; Chain Grate Stokers; Underfeed Stokers; Oil Fired; Firing and Services; Shavings and Refuse; Bagasse; Gas Fired; Waste Heat Boilers; Dredge Boat Boilers.

4. Overloads.

5. The Boiler as a Pressure Vessel.

6. Details of Construction, Heine Boilers.

The Sterling Wheelbarrow Company, of Milwaukee, is preparing to more completely serve the requirements of their customers by a large addition to their plant. This new addition will contain as much floor space as their present plant now occupies.

W. S. Quigley, president of the Quigley Furnace Specialties Company, Inc., sailed for Liverpool on the Baltic, February 15, for the purpose of further developing European connections of his company. Mr. Quigley will spend several weeks in England, France and Italy and visit the plants installing the Quigley system for preparing and burning pulverized coal and lignite.

At the fourth annual meeting of the Society of Ohio Safety Engineers, held in Cleveland, O., J. M. Woltz, safety director of the Youngstown Sheet & Tube Co., was re-elected chairman; A. C. Cook, claim agent Carnegie Steel Company at Youngstown, O., was re-elected vice chairman; E. R. Rose, secretary central safety committee Republic Iron & Steel Co., Youngstown, O., was re-elected secretary and treasurer, and Wallace Dunn, claim agent Republic Rubber Company, Youngstown, O., was elected assistant secretary and treasurer.

The Sterling Wheelbarrow Company of Milwaukee, announce the opening of a Boston office to handle their foundry line throughout the New England states. R. F. Jordon will have charge of this territory.

The Crane Company of Chicago, Ill., has placed an order for Surface Combustion Company firing equipment for three 12-foot galvanizing kettles. When these are installed the Crane Company will have five 12-foot kettles fired by

Surface Combustion Company's high pressure system.

Epping-Carpenter Pump Company takes pleasure in announcing that Theodore R. Hermanson, formerly of the Harrison works of the Worthington Machinery Corporation, has become associated with them as works manager.

Freyn, Brassert & Co., Engineers, Peoples Gas Building, Chicago, has been awarded a contract for two Brassert gas washing and drying units for the blast furnaces of the Detroit Iron & Steel Co., Detroit, Mich. The total number of blast furnaces equipped with Brassert gas washing and drying units is 68.

Trade Publications

Feed Pumps—The Coppus Engineering & Equipment Co., Worcester, Mass., has issued a catalog covering the Type CCC Coppus centrifugal turbo boiler feed pump. The many advantages of the pump are clearly described in an interesting manner.

Powdered Coal—The Quigley Furnace Specialties Company, 26 Cortlandt street, New York, has issued Bulletin, No. 10, descriptive of the Quigley Air Transport System for Transporting and Burning Powdered Fuel.

Wiring Devices—A new and very pleasing 64-page, 8½x10 inch catalog entitled "C-H Wiring Devices—Push Button Specialties," is being distributed by the Cutler-Hammer Manufacturing Company of Milwaukee. The appearance and contents indicate that much time and care were taken in the preparation of this book and that practically all of the wiring devices and push button specialties made by this company are illustrated, described and listed. The first 16 pages are devoted to a general description and listing of push sockets. These include the brass shell, porcelain and candle length types, all of which have the well-known C-H push button mechanism which has the N. E. C. standard rating of 660 watts. The next quarter of the catalog is devoted to switches comprising candelabra, canopy, pendant, door and door-bolt, surface, pull, tool-handle and appliance switches and also the C-H Feed Through Switches. Notably among the latter are the nationally advertised C-H Seventy Fifty Switches, the applications of which with household and industrial appliances, are illustrated.

The contractor dealer and large user of conduit fittings will find the center spread extremely useful. It is devoted to a complete table which lists the conduit fittings made by 11 different manufacturers, and gives the form and catalog number of the various fittings that may be readily used for mounting C-H receptacles and sockets. Another section illustrates and lists the C-H "Standard" Interchangeable Plugs and Receptacles and the Rock-Off type of plugs and receptacles. A section at the end is devoted exclusively to the well-known

C-H Automobile Lighting Switches. These are shown singly and in gangs of two to four and arranged for mounting, either parallel or in tandem. Wiring diagrams are furnished to illustrate the use of these switches with the various methods of controlling automobile lighting and ignition. The new line of Automobile switches, known as the Junior line, is also shown in these pages. It has a somewhat different mechanism than that of the "standard" line, nevertheless, it is sturdy and its construction is consistent with the high quality of other C-H devices. Among the other devices included, reference is made to remote control switches, vacuum cleaner control, etc., and to finish and other details. The book is well indexed and bound in striking orange buff colored cover. It is intended for distribution to jobbers, dealers, contractors, central stations, architects, and others interested.

The Ingersoll-Rand Company has recently issued a number of interesting booklets, which are listed below: Form No. 9120, 4-page, 6x9 catalog on Leyner Oil Furnace No. 3. Form No. 9010, 4-page, 6x9 inch bulletin on the "Sergeant" Ticket Cancelling Box. This ticket cancelling box is being used successfully by railroads, elevated railways, subway and trolley stations, toll bridges, ball grounds, race tracks, lecture halls, moving picture theaters, amusement parks and other places where great quantities of tickets must be disposed of without the possibility of their ever being placed in circulation again. Form No. 9123, 24-page, 6x9 catalog on "Imperial Tie Tamping Outfits." Catalog is profusely illustrated, showing application of the tie tamping outfit on many of the important railroads in the United States. Form No. 9026, 12-page catalog on "Ingersoll-Rand High Speed Piston Valve Steam Engine, Class 'FP.'" This engine is of the horizontal center crank type, and the steam valve is of the most approved design, permitting the use of the highest steam pressures and superheated steam. Catalog contains cross-sectional illustrations showing the machine detail. Form No. 9028, 18-page catalog on "Ingersoll-Rand Equipment for Sugar Factory and Refinery Service." Catalog is offered in both English and Spanish edition.

Society Meetings

Meeting of the Engineers Society of Western Pennsylvania, Tuesday, March 18. Paper to be read by Maj. F. F. McIntosh, assistant chief metallurgist, technical staff United States Army, entitled, "The Manufacture of Steel for Ordnance in England and France."

Pittsburgh Section A. I. E. E. Tuesday evening, March 11, 8 o'clock, Chamber of Commerce Building, Pittsburgh. J. A. Seede, of the engineering department, General Electric Company, Schenectady, N. Y., will present a paper on electric furnaces. The paper will be illustrated with lantern slides.

The Blast Furnace *and* Steel Plant

Pittsburgh, March, 1919.

MORGAN CONTINUOUS ROLLING MILLS *STANDARD OF THE WORLD*



THE MORGAN CONSTRUCTION CO.
HAS DESIGNED AND MANUFACTURED
101 ROLLING MILLS

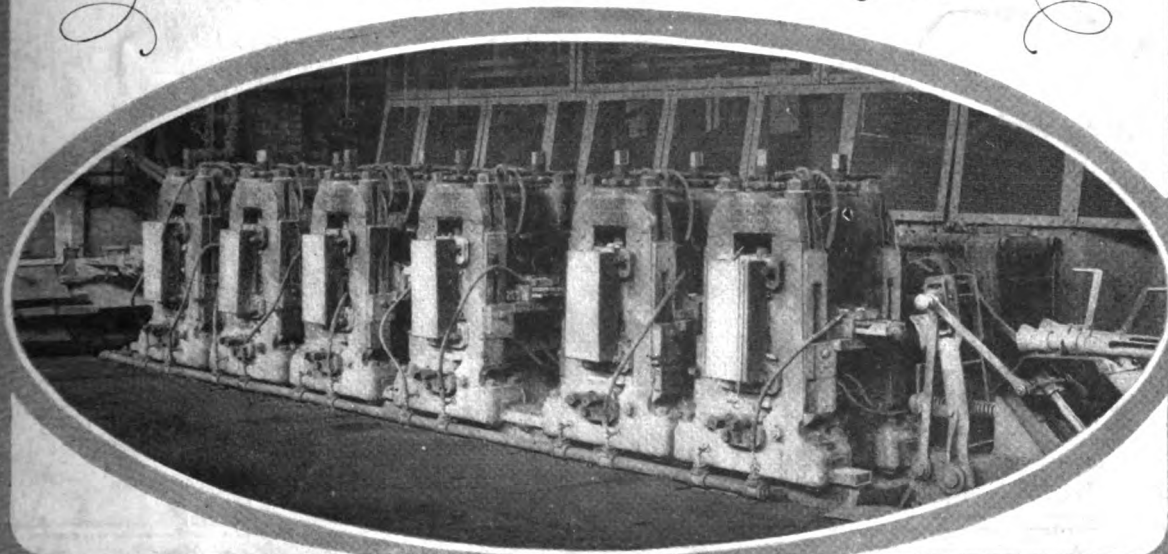
80 in the
United States
of America

5 in Canada
5 in England
4 in Germany
3 in India ~

1 in France
1 in Belgium
1 in Austria
1 in Australia

AS CONSULTING ENGINEERS—
we prepare estimates and make draw-
ings for contemplated rolling mills. Our
services include electrical engineering

AS MANUFACTURING ENGINEERS
we enter into contracts for complete
rolling mills, producer-gas machines,
and wire drawing equipment



MORGAN CONSTRUCTION CO.
WORCESTER, MASS. U.S.A.